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FLOOD PLAIN INFORMATION, WHITE CLAY CREEK, NEW CASTLE COUNTY, D--ETC(U)
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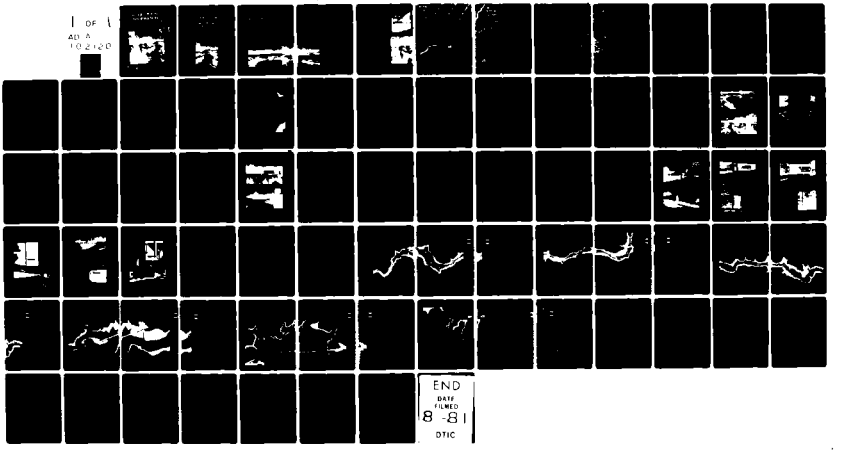


FLOOD PLAIN INFORMATION

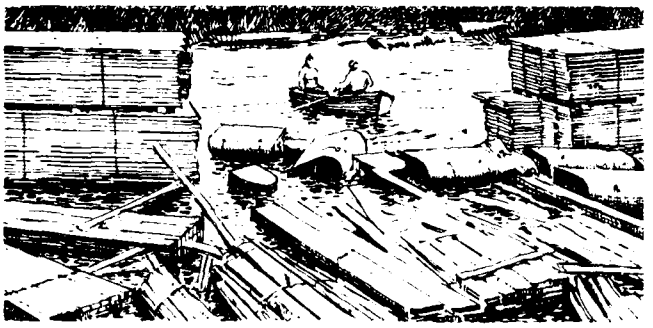
WHITE CLAY CREEK

NEW CASTLE COUNTY, DELAWARE

PREPARED FOR THE NEW CASTLE COUNTY DEPARTMENT OF PLANNING BY THE DEPT. OF THE ARMY, PHILADELPHIA DISTRICT, CORPS OF ENGINEERS, PHILADELPHIA, PA.

JULY 1972

REPT. NO. DAEN/NAP-82040/FPI 44-72/07



FLOODS
IN
NEWARK, DELAWARE
WHITE CLAY CREEK

FLOODS

IN NEWARK, DELAWARE

This folder is an announcement of and supplement to the "Flood Plain Information (FPI) Report, White Clay Creek, New Castle County, Delaware." The report has been prepared to emphasize the importance of flood potential and flood hazards in land use planning and in making decisions concerning flood plain utilization.

Although Newark has suffered extensive damage from major floods in the past, studies indicate that even larger floods can occur in the future. Emphasis is given to future floods in the FPI Report. Maps, profiles, and cross sections have been included to illustrate the possible extent and severity of future floods.

Included in this folder is a photograph showing possible future flood heights at the Delaware Route 7 highway bridge crossing White Clay Creek. The flood height shown for a large flood, the Intermediate Regional Flood (IRF), is one that occurs once in 100 years on the average, although it could occur in any year. Also indicated is the flood height that would be reached if a very large flood, the Standard Project flood (SPF), should occur. The Standard Project Flood represents the reasonable upper limit of expected flooding in the study area.

Beginning of a Spring Thaw on White Clay Creek.

EXPERIENCED AND POSSIBLE FUTURE FLOOD HEIGHTS FOR U.S.G.S. GAGE NO. 4790, 3.5 MILES EAST OF NEWARK, DELAWARE

Date of Crest	Stage	Elevation
	Feet	Ft.-m.s.l.d.
July 5, 1937	23.0	34.6
August 10, 1967	16.4	28.0
September 12, 1960	16.1	27.7
August 18, 1955	15.8	27.4
Overbank	—	24.6
POSSIBLE FUTURE FLOODS FOR PLANNING		
Large (100 Year)— Intermediate Regional Flood (IRF)	19.3	30.9
Very Large—Standard Project Flood (SPF)	30.0	41.6

Inside are sketches illustrating the horizontal and vertical relationships of flooded areas and a flood area map from the report showing the extent of both an Intermediate Regional Flood (IRF) and a Standard Project Flood (SPF).

ACTION is needed

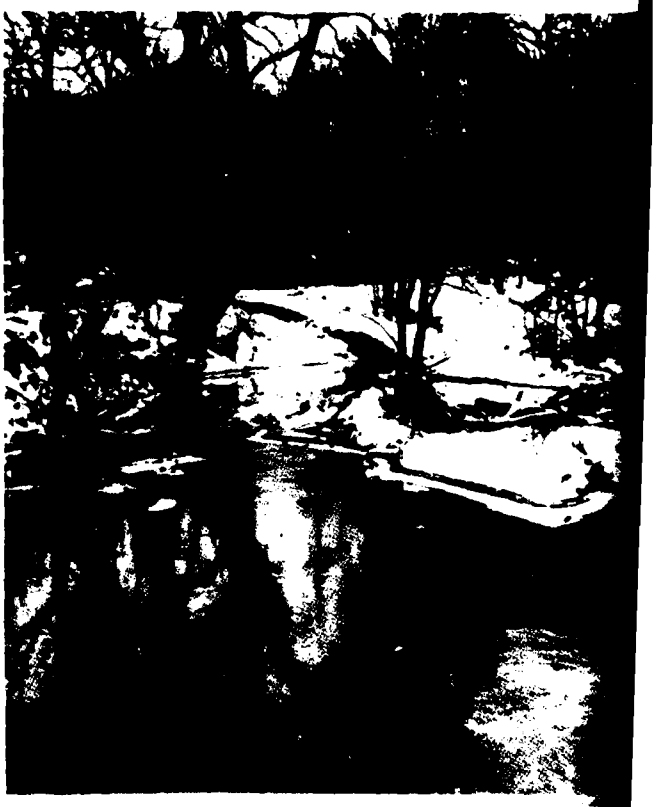
The flood plain of White Clay Creek in the vicinity of Newark, Delaware, is not entirely developed and expansion and redevelopment of industrial facilities can be expected in the future. The devastating effects of flooding will continue to increase unless action is taken.

Effective regulatory measures such as zoning ordinances and building codes can be designed to prevent increased flood damages. Flood proofing can reduce potential damages to properties already subject to flooding, and additional works to modify flooding can also be a part of the long-run solution. Local flood control projects have already provided partial flood protection.

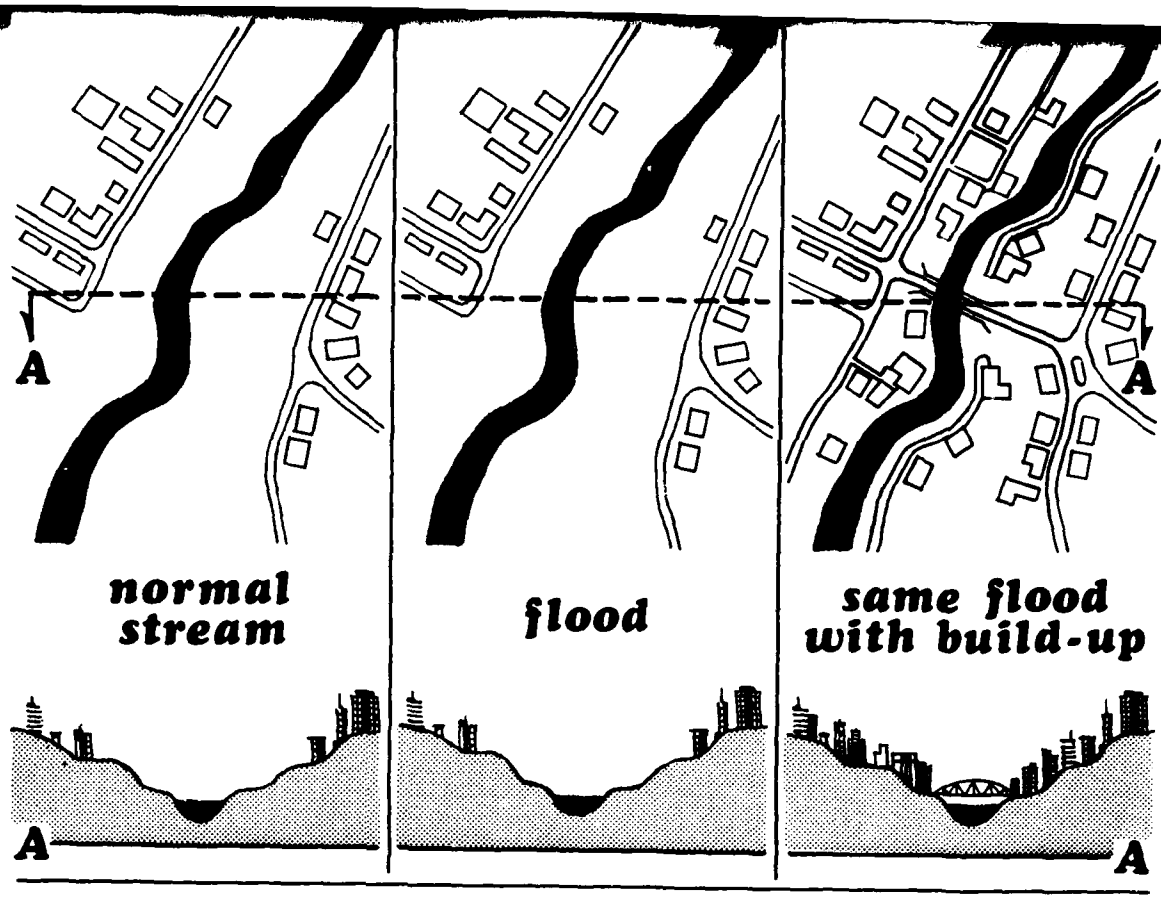
The City of Newark is not the only community with flooding problems. Flood plain information has already been provided for many of several thousand flood-plagued communities. Nearly 450 of those having FPI Reports by the end of 1971 have adopted or strengthened regulations, while 800 others have them under study. An additional 700 communities have used the FPI Reports to establish interim land use control.

This folder has been prepared for the New Castle County Department of Planning by the U.S. Army Corps of Engineers from data in the report "Flood Plain Information, White Clay Creek, New Castle County, Delaware." Copies of the report and this folder are available upon request from the New Castle County Department of Planning.

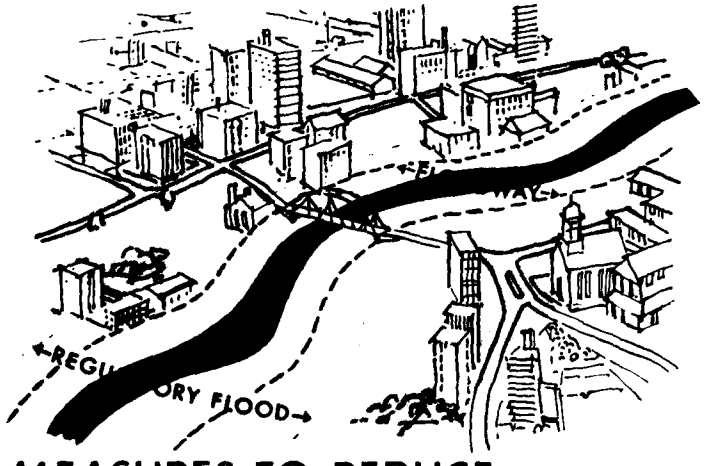
Possible future flood heights at Delaware Route 7 highway bridge across White Clay Creek.



BUILDING in the FLOOD PLAIN can make FLOODS WIDER and DEEPER



TOOLS of FLOOD PLAIN MANAGEMENT for the reduction of Flood Damage and



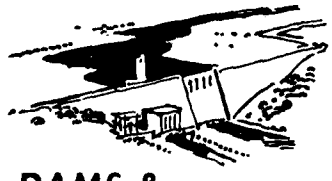
MEASURES TO REDUCE *VULNERABILITY TO FLOODS*

provide for a future with more freedom from flood damage, often at minor cost and with little adverse effect on the environment . . . . . .

REGULATIONS
(ZONING, BUILDING CODES, SUBDIVISION)
• FLOOD PROOFING • RELOCATIONS •
• URBAN RENEWAL •

MEASURES TO MODIFY FLOODS

are often required to alleviate existing problems and sometimes to forestall future problems . . .



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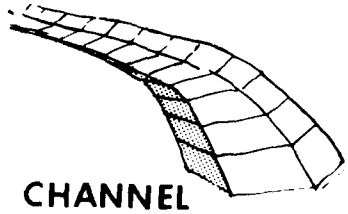
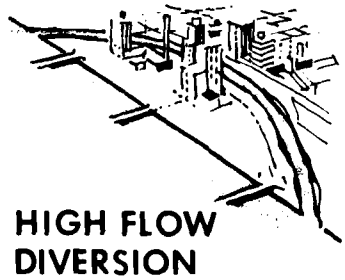
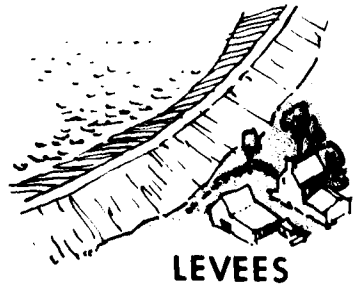


CHANNEL ENLARGEMENT



HIGH FLOW DIVERSION



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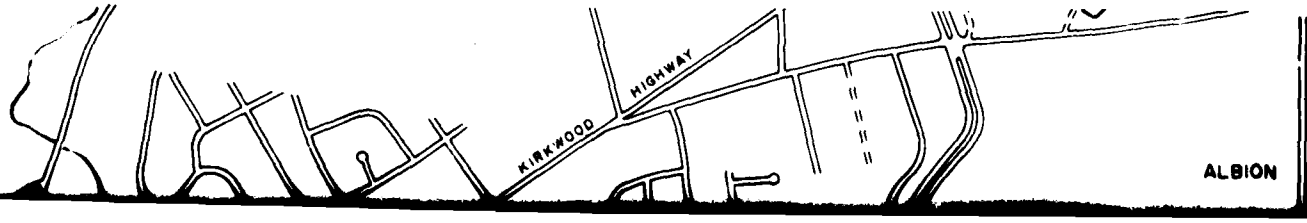

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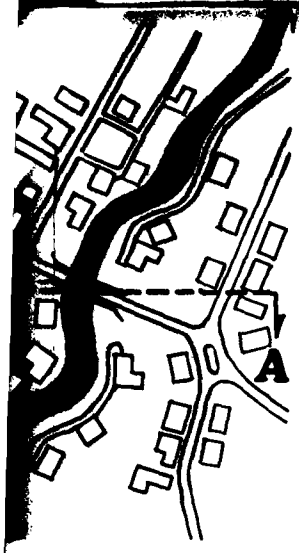

this ENCROACHMENT can change a Small Flood into a MAJOR FLOOD

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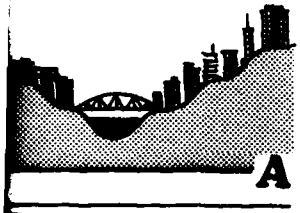

lood Damage and Human Suffering

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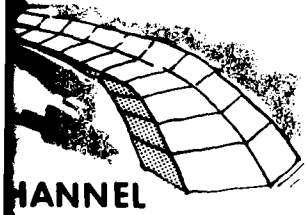

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LARGEMENT

LEVEES

OTHER MEASURES
aid the Flood Plain occupant in coping with floods . . .

EDUCATION

TAX ADJUSTMENTS

FLOOD INSURANCE

WARNING & EMERGENCY PLANS

FLOOD PATTERNS
FOR NEWARK, DELAWARE

MEASURES TO REDUCE *VULNERABILITY TO FLOODS* provide for a future with more freedom from flood damage, often at minor cost and with little adverse effect on the environment . . . . . .

REGULATIONS
(ZONING, BUILDING CODES, SUBDIVISION)
• FLOOD PROOFING • RELOCATIONS •
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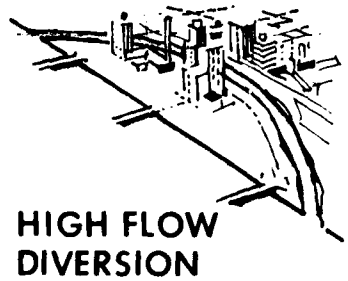
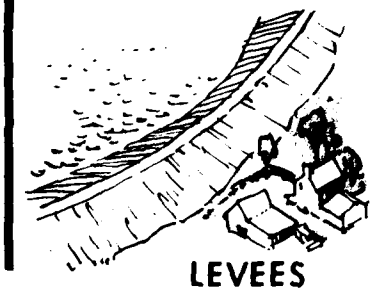


HIGH FLOW DIVERSION



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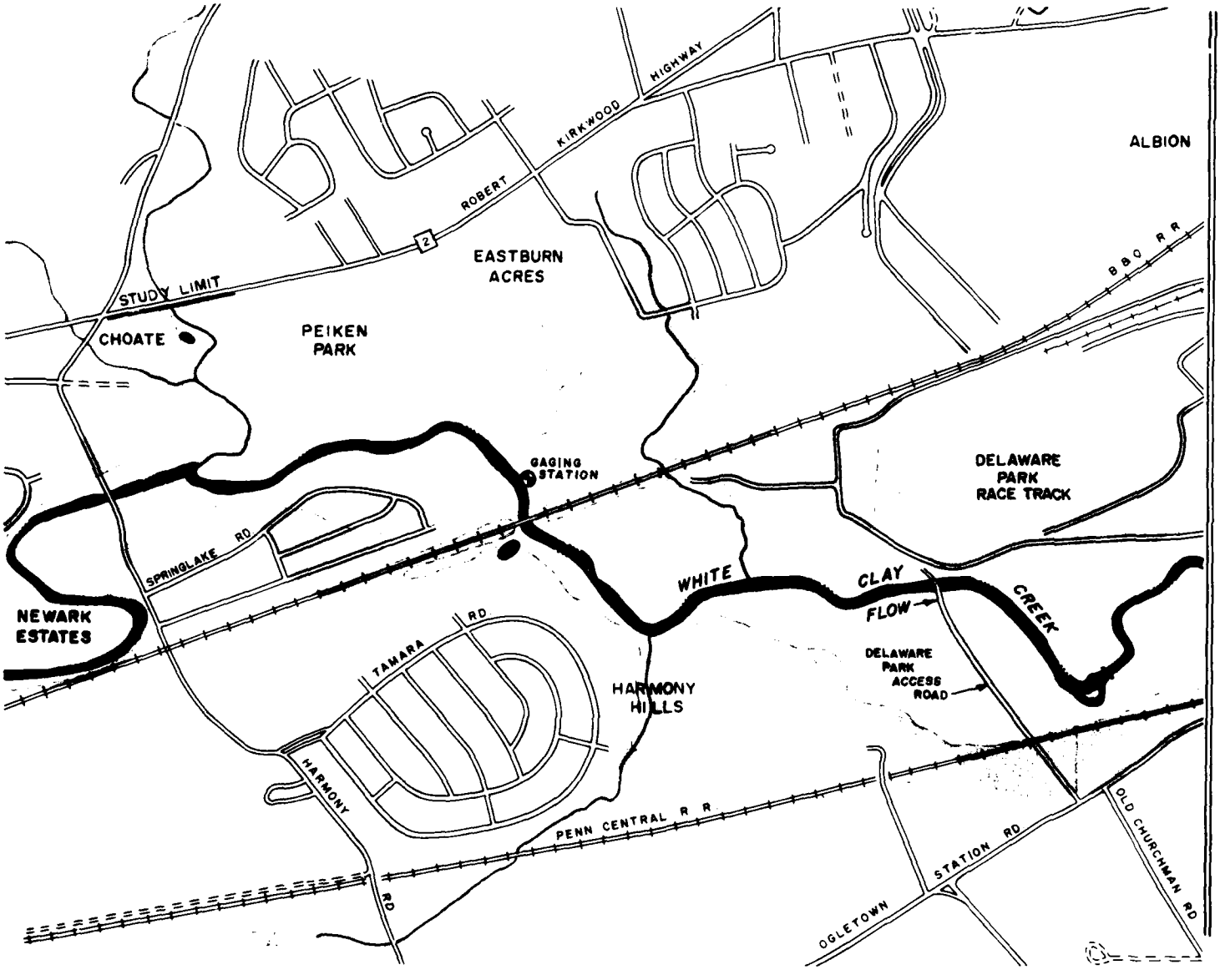

NLARGEMENT

ADJUSTMENTS

LEVEES

FLOOD INSURANCE

WARNING & EMERGENCY PLANS

FLOOD PATTERNS
FOR NEWARK, DELAWARE

LEGEND

approximate limits of overflow

NORMAL STREAM

INTERMEDIATE REGIONAL FLOOD (IRF)

STANDARD PROJECT FLOOD (SPF)

PROFILES in the *Flood Plain Information Report* show elevations of these floods for the entire study area

41

TO THE REQUESTOR:

This Flood Plain Information (FPI) Report was prepared by the Philadelphia District office of the U.S. Army Corps of Engineers, under the continuing authority of the 1960 Flood Control Act, as amended. The report contains valuable background information, discussion of flood characteristics and historical flood data for the study area. The report also presents through tables, profiles, maps and text, the results of engineering studies to determine the possible magnitude and extent of future floods, because knowledge of flood potential and flood hazards is important in land use planning and for management decisions concerning floodplain utilization. These projections of possible flood events and their frequency of occurrence were based on conditions in the study area at the time the report was prepared.

Since the publication of this FPI Report, other engineering studies or reports may have been published for the area. Among these are Flood Insurance Studies prepared by the Federal Insurance Administration of the Federal Emergency Management Agency, Flood Insurance Studies generally provide different types of flood hazard data (including information pertinent to setting flood insurance rates) and different types of floodplain mapping for regulatory purposes and in some cases provide updated technical data based on recent flood events or changes in the study area that may have occurred since the publication of this report.

It is strongly suggested that, where available, Flood Insurance Studies and other sources of flood hazard data be sought out for the additional, and, in some cases, updated flood plain information which they might provide. Should you have any questions concerning the preparation of, or data contained in this FPI Report, please contact:

U.S. Army Corps of Engineers
Philadelphia District
Custom House, 2nd and Chestnut Streets
Philadelphia, PA 19106

ATTN: Flood Plain Mgt. Services Branch, NAPEN-M

Telephone number: (215) 597-4807

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

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New Castle County, Del.	Flood forecasting
New Castle County Dept. of Planning	Flood plains

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The portion of New Castle County covered by this report was subject to flooding from White Clay Creek, Dela. These areas were severely damaged by floods in 1937, 1955, 1967, and 1972. Included within the scope of this report is a history of flooding along White Clay Creek. Technical data was presented thru maps, photographs, profiles and cross sections.

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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

Under authority 206 of the 1960 Flood Control Act as amended the flood plain information was prepared by the U.S. Army Corps of Engineers Philadelphia District at the request of the New Castle County Department of Planning. The information should be considered for its historical nature. Since the publication of this FPI report other Flood Insurance studies have been undertaken and should also be consulted for more current information.

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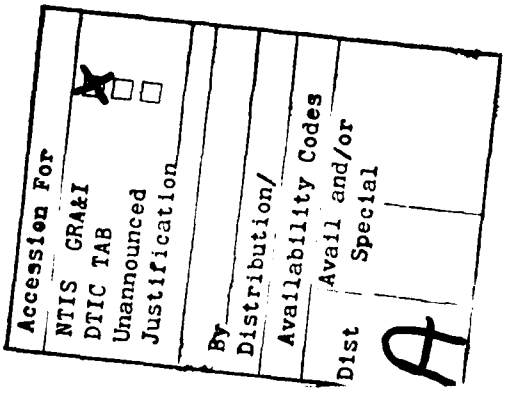
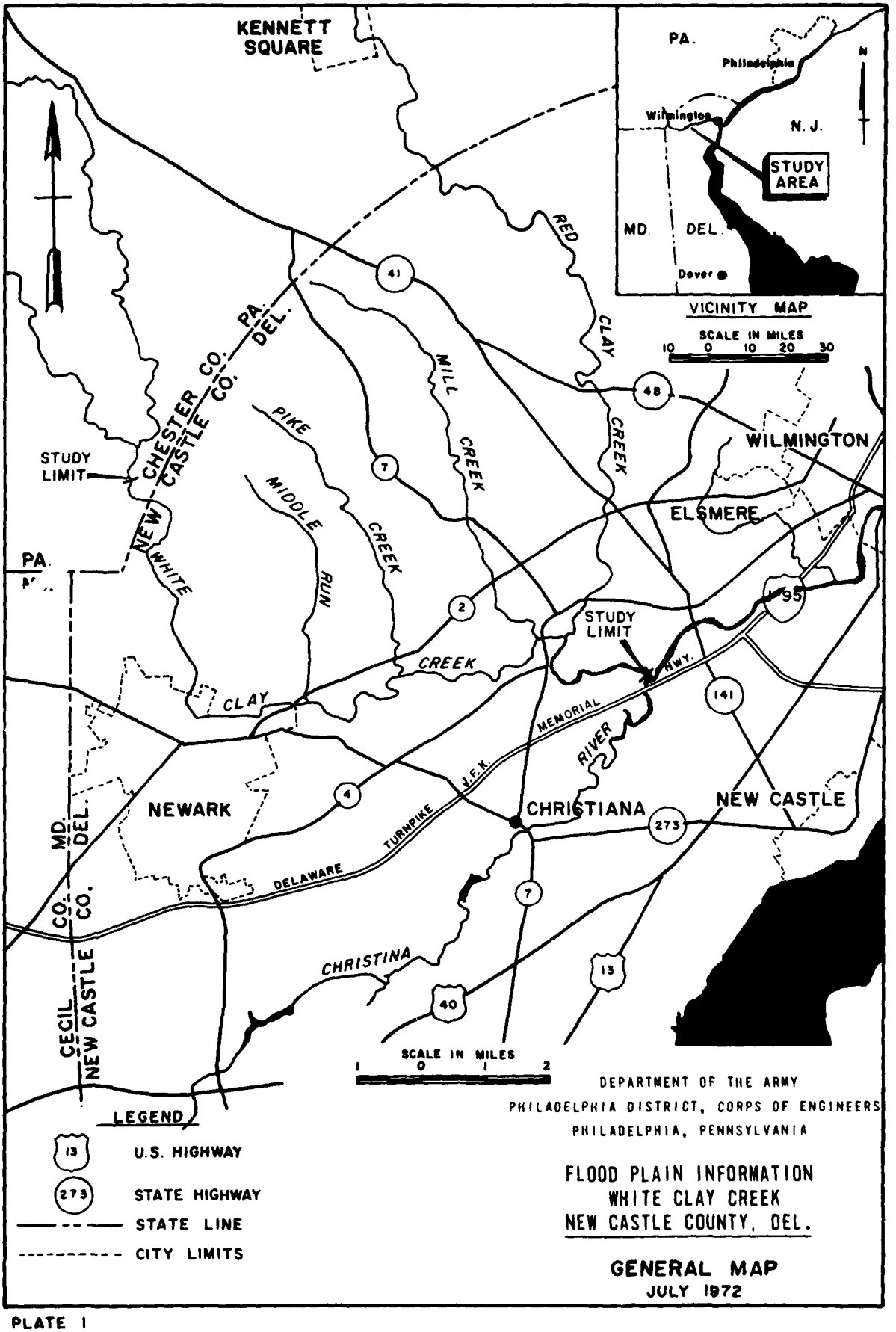




DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

FLOOD PLAIN INFORMATION
WHITE CLAY CREEK
NEW CASTLE COUNTY, DEL.

GENERAL MAP
JULY 1972

PLATE 1

PREFACE

The portion of New Castle County covered by this report is subject to flooding from the White Clay Creek. The properties along White Clay Creek are primarily residential with some industries near Newark, Delaware, and have been severely damaged by the floods of 1937, 1955, 1967, and 1972. The open spaces of the flood plains which are now under pressure for development are extensive. Although large floods have occurred in the past, studies indicate that even larger floods are possible.

This report has been prepared because a knowledge of flood potential and flood hazards is important in land use planning and for management decisions concerning flood plain utilization. It includes a history of flooding along White Clay Creek and identifies those areas that are subject to possible future floods. Special emphasis is given to these floods through maps, photographs, profiles, and cross sections. The report does not provide solutions to flood problems; however, it does furnish a suitable basis for the adoption of land use controls to guide flood plain development and thereby prevent intensification of the loss problems. It will also aid in the identification of areas where other flood damage reduction techniques such as works to modify flooding and adjustments, including flood proofing, might be embodied in an overall Flood Plain Management (FPM) program. Other FPM program studies - those of environmental attributes and the current and future land use role of the flood plain as part of its surroundings - would also profit from this information.

At the request of the New Castle County Department of Planning and endorsement of the Delaware State Department of Highways and Transportation, this report was prepared by the Philadelphia District, U.S. Army Corps of Engineers, under the continuing authority provided in Section 206 of the 1960 Flood Control Act, as amended.

Assistance and cooperation of the United States Geological Survey (U.S.G.S.), the Delaware State Department of Highways and Transportation, the New Castle County Department of Planning, the Delaware River Basin Commission, the Wilmington Morning News, and private citizens in supplying useful data and photographs for the preparation of this report are appreciated.

Additional copies of this report can be obtained from the New Castle County Department of Planning. The Philadelphia District Office, upon request, will provide technical assistance to planning agencies in the interpretation and use of the data presented as well as planning guidance and further assistance, including the development of additional technical information.

BACKGROUND INFORMATION

Settlement

White Clay Creek Hundred was first settled in the latter part of the seventeenth century. Although early development of the area was limited to agriculture, the availability of water power soon promoted the construction of mills, and the milling of agricultural products became the major industrial activity of the area. The mills built on the banks of White Clay Creek and other creeks in New Castle County attracted farmers from Pennsylvania and Maryland who then traveled on to the shipping and trading centers of the larger metropolitan areas. One of the early communities to be established on the banks of White Clay Creek as a result of milling and commerce was Newark. First founded at the intersection of two public roads, Newark grew slowly and remained a small crossroads village until the Revolutionary War. After the war, Newark began to prosper and the conversion of an old grist mill to a woolen mill in 1845 brought the fiber industry and new prosperity to the town.

Prior to the 1950's, Newark was dependent upon the University of Delaware, founded in 1921, and the paper, fiber and textile industries which had long since replaced the early mills. In recent years, with the establishment of several major industries in and around the city, Newark has continued to grow steadily and suburban areas are developing at an even faster rate.

The Stream and Its Valley

White Clay Creek, with a total drainage area of 162 square miles, is a major tributary of Christina River. With its headwaters in southeastern Pennsylvania, White Clay Creek flows generally in a southern direction through New Castle County, Delaware, to the City of Newark, and then eastward to its confluence with Christina River south of Stanton, Delaware.

Above Newark, the stream flows through a narrow, wooded flood plain with high bordering hills. Below Newark, White Clay Creek meanders through a relatively wide, flat flood plain and finally through marshy lowlands near its confluence with Christina River. In this 14.7 mile study reach, White Clay Creek falls approximately 100 feet for an average slope of 7 feet per mile. The portion of White Clay Creek included in this study is shown on the general map. Drainage areas contributing to runoff at locations in or near the study area are shown in Table 1.

TABLE 1
DRAINAGE AREAS ALONG WHITE CLAY CREEK

Location	Mileage Above Mouth	Drainage Area	
		Tributary sq. mi.	Mainstream sq. mi.
Pennsylvania-Delaware State Line	14.7	--	60.0
Unnamed Tributary	14.5	1.1	--
Unnamed Tributary	14.0	0.9	--
U.S.G.S. Gage No. 4785, North of Newark	12.5	--	66.7
Unnamed Tributary	10.2	0.8	--
Middle Run	8.4	4.1	--
Pike Creek	5.8	6.3	--
U.S.G.S. Gage No. 4790 East of Newark	5.2	--	87.8
Mill Creek	2.9	12.0	--
Above Confluence with Red Clay Creek	2.5	--	104.0
Red Clay Creek at Mouth	2.5	54.0	--
At Mouth (Christina River Not Included)	0.0	--	162.0

The climate is characterized by warm, humid summers and damp, but not cold, winters. Average annual precipitation is 46 inches, with the greatest amounts of rainfall generally occurring in July and August and the least amounts occurring in autumn and early winter.

Developments in the Flood Plain

Above Newark, Delaware, the flood plain of White Clay Creek is wooded and undeveloped except for a few widely scattered residential structures. In the vicinity of Newark, however, development is more concentrated.

Several industrial firms are located on the flood plain near the Delaware Route 72 bridge, and at least one of these industries has experienced flooding from White Clay Creek in the past. Further downstream, there are several clusters of residential development on or near the flood plain. Upstream from the confluence of Red Clay and White Clay Creeks, a large tract of land has been developed into Delaware Park Race Track, which suffered damage from the flood of July 5, 1937. In addition to the industrial, residential, and commercial development of the flood plain, railroads, highways, local roads, and utilities could be subject to flooding.

Five dams are located on White Clay Creek, all of which are the low-flow type having no significant storage capacity. In addition, a multi-purpose dam for water supply and recreation has been proposed for a site approximately 1-½ miles north of Newark. If constructed, this dam would create a reservoir extending six miles up White Clay Creek into Pennsylvania, and could significantly alter future floodflows.

Population trends in the area indicate that development is increasing rapidly. In the period 1950-1960, Newark's population increased approximately 65%, while White Clay Creek Hundred registered an increase of over 80%, with most of the accompanying development occurring within a short distance of Newark. As the population continues to increase, flood plain areas will come under increasing pressure for development unless regulatory measures are taken.

A tentative Comprehensive Development Plan has been prepared for New Castle County. The plan covers proposed development through the year 1985. In regard to flood plain management, the plan proposes the preservation of open spaces along various stream valleys throughout the county and several parcels of tidal marsh in the southeast portion of the county.

FLOOD SITUATION

Sources of Data and Records

The U.S. Geological Survey currently operates two stream gages on the main stem of White Clay Creek. Gage No. 4785, located 2.2 miles north of Newark, Delaware, with a drainage area of 66.7 square miles, has been in operation from February 1952 to September 1959 and from July 1962 to the present time. The other Gage, No. 4790, located 3.5 miles east of Newark, has a drainage area of 87.8 square miles and has been in operation over the following periods: October 1931 to September 1936, June 1943 to September 1957, and October 1959 to the present time.

To supplement the records at the above gaging stations, newspaper files, historical documents and records were searched for information concerning past floods. These records have helped develop a knowledge of floods which have occurred on White Clay Creek.

Maps prepared for this report were based on U.S. Geological Survey Quadrangle sheets entitled: "Newark West, Maryland-Delaware-Pennsylvania", 1953; "Newark East, Delaware", 1953; and "Wilmington South, Delaware-New Jersey", 1948. Structural data on bridges and culverts were obtained by field surveys performed by Corps of Engineers, Philadelphia District, personnel.

Flood Season and Flood Characteristics

White Clay Creek's four highest-measured floods occurred during June, July, August, and September; two of the four floods were the result of heavy rainfall associated with Hurricanes "Agnes" and "Donna." One flood was also caused by rainfall from a series of severe summer thunderstorms. However, heavy rainfall on the basin has caused major floods during all seasons of the year. In addition to floods caused by the aforementioned conditions, the White Clay Basin may be susceptible to floods from snowmelt combined with rainfall. During floods, flows can increase from normal to peak values in a relatively short period of time with high velocities in the main channel. The marsh land near the confluence of the White Clay Creek and the Christina River is also subject to tidal and fluvial flooding from the Christina River.

Factors Affecting Flooding and Its Impact

Obstructions to floodflows - Natural obstructions to floodflows include trees, brush and other vegetation growing along the stream banks in floodway areas. Man-made encroachments on or over the streams such as dams, bridges and culverts can also create more extensive flooding than would otherwise occur. Natural obstructions to floodflows are shown on Figures 1 and 2 on page 7.

During floods, trees, brush and other vegetation growing in floodways impede floodflows, thus creating backwater and increased flood heights. Trees and other debris may be washed away and carried downstream to collect on bridges and other obstructions to flow. As floodflow increases, masses of debris break loose and a wall of water and debris surges downstream until another obstruction is encountered. Debris may collect against a bridge until the unbalanced load exceeds the structural capacity and the bridge is destroyed. The limited flow capacity of obstructive bridges or culverts, debris plugs at the culvert mouth or a combination of these factors retard floodflows resulting in flooding upstream, erosion around the culvert entrance and bridge approach embankments and possible damage to the overlying roadbed.

In general, obstructions restrict floodflows and result in overbank flows and unpredictable areas of flooding; destruction of or damage to bridges and culverts; and, an increased velocity of flow immediately downstream. It is impossible to predict the degree or location of the accumulation of debris; therefore, for the purpose of this report, it was necessary, in the development of the flood profiles, to assume that there would be no accumulation of debris to clog any of the bridge or culvert openings.

A high water mark in the vicinity of the stream gage east of Newark indicates that flooding occurred on July 5, 1937, at a height greater than any floods recorded by the gage. The great flooding height resulted from a backwater effect due to a railroad bridge downstream from the gage. The obstructive bridge has since been raised and widened, making a considerably higher discharge necessary to create a stage height similar to that which occurred during the July 5, 1937, flood.

The 5 dams located on the main stem of White Clay Creek have no flood control capacities and will not seriously alter flow characteristics of floodwaters. White Clay Creek is also spanned by 12 bridges. Pertinent bridge information can be found in Table 6 on Page 15. Many of these bridges are obstructive to floodflows.

Flood damage reduction measures - There are no existing flood control or related measures in the study area or upstream in the watershed. Zoning ordinances, building codes or regulatory measures for the reduction of flood damages have not, as yet, been established. This study has been requested so that it may be used as a basis for the development of flood plain management regulatory measures that can be included in future planning and zoning ordinances.

The State of Delaware has under consideration the construction of a water supply and recreation dam at a location above Newark near the U.S.G.S. gage site. Although planned for water supply and recreation, this project will offer flood reduction benefits during flood occurrences. The project was originally evaluated and proposed by the Corps of Engineers in its overall Basin Comprehensive Plan, House Document No. 522, 87th Congress, 2nd Session. When approved, the project will be financed and constructed by the State of Delaware.

Other factors and their impacts - In the lower reaches of White Clay Creek above the confluence with the Christina River, areas become inundated largely due to the influence of the Christina River at high stages. When combined with high runoff from the White Clay Creek basin, high stages on the Christina River aggravate flooding conditions by increasing the height and duration of the flooding on White Clay Creek (backwater effect).

Forecasting systems can predict storms which may cause flooding conditions. Flood warning systems can alert home owners and industries of rising waters and provide time to implement flood fighting and emergency evacuation plans. Removing or securing buoyant materials stored on the flood plain may reduce damages to life and properties downstream.

Flood warning and forecasting - The National Oceanic and Atmospheric Administration (NOAA) maintains year-roung surveillance of weather conditions at the Wilmington, Delaware, and Philadelphia, Pennsylvania, airports. Flood forecasting centers located at Harrisburg, Pennsylvania, and Trenton, New Jersey, release anticipated weather conditions and predicted high stages to radio and television stations and the local press media. Local inhabitants depend entirely on the above-mentioned media for flood warnings.

Flood fighting and emergency evacuation plans - Although there are no formal flood fighting or emergency evacuation plans for the White Clay Creek watershed, provisions for alerting area residents through local communications media and coordinating operations for New Castle County are accomplished by the County Civil Defense Office. This office maintains communications with the State Civil Defense Headquarters and the National Weather Service and establishes a "flood watch" during the earliest stages of a flood threat. Flood fighting evacuation and rescue activities are coordinated on a county-wide basis with local public agencies.

Material storage on the flood plain - Along the upper reaches of White Clay Creek, development is sparse. Near Newark, a few industries border the creek; and, farther downstream, recent housing developments encroach on the flood plain. Some of the industries and commercial buildings have floatable materials stored on the flood plain. Figure 3 is the storage yard at Lowe's of Wilmington showing how minor floodwaters can rearrange floatable materials. In reaction to flooding of this nature, Lowe's has raised the ground elevation of their storage yard. Floatable materials stored on the flood plain should be secured or transported to higher ground when flood warnings are given. Otherwise, floatable materials may be carried away by floodflows, causing serious damage to structures downstream or clogging bridge openings and creating more hazardous flooding problems.

FIGURE 1 - During floods, this debris may be carried to a downstream bridge and restrict the passage of water.

FIGURE 2 - This scenic island has collected debris from past floods when it was overtopped.

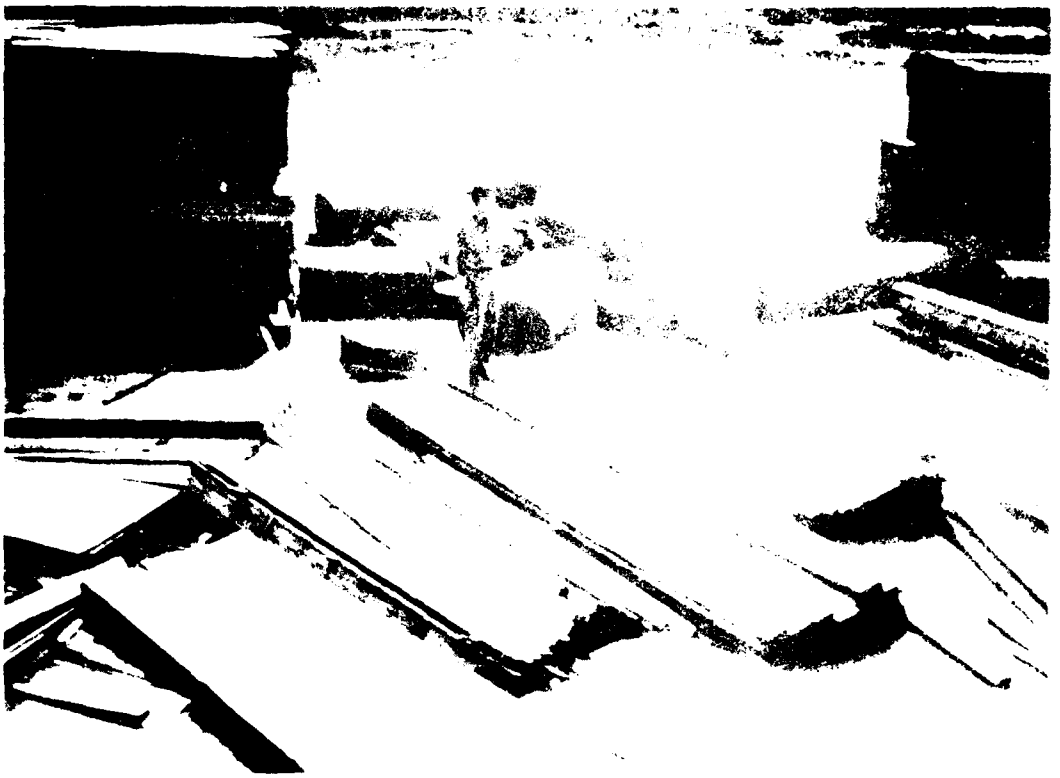


FIGURE 3 - The storage yard at Lowe's of Wilmington shows how floodwaters can rearrange floatable materials.

PAST FLOODS

Summary of Historical Floods

Floods causing significant damage in the Newark, Delaware, area are reported to have occurred in 1933, 1936, 1937, 1946, 1955, 1960, 1967, and 1972. Among these, the July 5, 1937, flood had the highest recorded stage on the White Clay Creek at the U.S.G.S. Gage east of Newark, Delaware. Historical floods included the flood of 1843; however, little data is available concerning its severity.

Flood Records

Information for historical floods on White Clay Creek was obtained from two stream gaging stations maintained by the U.S. Geological Survey. The first gage is located approximately 12.5 miles above the mouth of White Clay Creek with streamflow records from 1952 to 1959 and from 1962 to the present time. The second gage is located near Newark, approximately 5.2 miles above the stream mouth. Streamflow records exist at the gage from 1931 to 1936; 1943 to 1957; and, 1959 to the present time. A high water mark near this gage indicates that the July 5, 1937, flood is the flood of record. However, the stage was influenced by an obstructive railroad bridge located downstream of the gage and the peak flow value is not available for this flood. The highest peak flows recorded at the two stream gages on White Clay Creek were caused by rainfall runoff from Hurricane "Agnes." During "Agnes," the upper portion of the drainage basin received the greatest amount of rainfall. Evidence of this is reflected in the gage records, which show higher peak flows recorded at the gage upstream of Newark than at the other gage downstream of Newark. The difference in flow values also indicates that floodwaters were stored in overbank areas and released at a slower discharge rate. High water marks of past floods on White Clay Creek and vivid descriptions of flooding were obtained by interviews with local residents and from newspaper files and historical documents. Crest stages, elevations and discharges for known floods at the two U.S.G.S. gaging stations are shown in Tables 2 and 3.

TABLE 2
FLOOD CREST ELEVATIONS
WHITE CLAY CREEK NORTH OF NEWARK, DELAWARE
(U.S.G.S. Gaging Station No. 4785)[a]

Date of Crest	Estimated Peak Discharge cfs	Stage[b] feet	Elevation[c] feet-m.s.l.d.
June 23, 1972	10,200	13.8[d]	92.4
August 10, 1967	4,540	10.0	88.6
August 18, 1955	4,050	9.2	87.8
March 7, 1967	3,950	9.2	87.8
February 13, 1966	3,910	9.0	87.6
January 9, 1964	3,480	8.5	87.1

(a) Drainage area = 66.7 square miles.
(b) Overbank flooding begins at stage of 7.0 feet as per U.S.G.S.
(c) Gage datum is 78.6 feet, mean sea level datum.
(d) High water mark.

TABLE 3
FLOOD CREST ELEVATIONS
WHITE CLAY CREEK EAST OF NEWARK, DELAWARE
(U.S.G.S. Gaging Station No. 4790)[a]

Date of Crest	Estimated Peak Discharge cfs	Stage[b] ft.	Elevation[c] feet-m.s.l.d.
July 5, 1937[d]	--	23.0	34.6
June 23, 1972	9,020	17.7	29.3
August 10, 1967	6,640	16.4	28.0
September 12, 1960	6,340	16.1	27.7
August 18, 1955	6,010	15.8	27.4
January 3, 1936	6,030	15.4	27.0

(a) Drainage area = 87.8 square miles.
(b) Overbank flooding begins at stage of 13.0 feet.
(c) Elevations are based on the gage zero reading at 11.6 feet, mean sea level datum.
(d) During the July 5, 1937, storm, the gage was not in operation. The elevation reached was obtained from surveyed flood marks. The great height reflected the constrictive opening of the downstream Baltimore & Ohio Railroad bridge. After the flood, the bridge underclearance was raised and the opening widened.

Flood Descriptions

The following are descriptions of known large floods that have occurred on White Clay Creek in the vicinity of Newark, Delaware, and neighboring communities:

July 5, 1937 - In mid-afternoon of July 5, 1937, Newark suffered thousands of dollars damage from flooded cellars and impassable streets due to a two-hour downpour following a gentle morning rain.

EXCERPTS FROM THE WILMINGTON MORNING NEWS, JULY 6, 1937 [a]

Some idea of the intensity of the storm may be gained by stating that the White Clay Creek, on the outskirts of town, swept the level of the roadway (Rt. 72), threatening destruction of the bridge spanning the stream and making it necessary for only two or three cars at a time to pass over the raging waters . . . The high waters damaged the surface of Paper Mill Road and swept away the bridge on the road from Stanton to Newark . . . The rains played havoc at Delaware Park race track. Hundreds of cars stalled including the armored car with the day's take. Flood waters washed out the B & O tracks and undermined a spur on which the race train to Philadelphia was waiting.

August 18-19, 1955 - The August 18-19, 1955, flood, the fourth highest flow of record at the gage east of Newark, was the result of Hurricane "Diane." This storm caused an average of 3 to 4 inches of precipitation throughout the study area. However, Hurricane "Connie", which passed less than a week earlier, saturated the soil with 8 inches of rain and left the river stages above normal. Diane's rainfall was immediately turned to runoff causing rapidly rising floodflows on White Clay Creek.

September 12, 1960 - The third highest flow recorded by the gage east of Newark, Delaware, occurred on September 12, 1960, and resulted from Hurricane "Donna". This storm moved northward off the coast of New Jersey, causing high winds and heavy rainfall of 6 to 8 inches in the study area.

August 10, 1967 - The second highest flow of record at both gages located on White Clay Creek occurred on August 10, 1967, and resulted from intense rainfall associated with a severe thunderstorm. This storm followed the violent thunderstorm of August 3, 1967, which saturated the soil and produced heavy runoff. During August 4-5th close to 4 inches of precipitation was recorded at Newark, Delaware. This was followed by 3.5 inches of rain falling during August 9-10th. The resulting flood caused sewers to back up and heavy inundation of roads and cellars in the Newark area.

(a) Simulated from newspaper clippings

EXCERPTS FROM THE WILMINGTON MORNING NEWS, AUGUST 10, 1967

2nd TORRENTIAL RAIN IN WEEK HITS UPSTATE [a]

The second torrential rainfall within a week - 3 inches of it - lashed northern Delaware last night and early today to block some roads completely and slow or stop traffic on others... Scores of sewers, cellars, and anything low enough was flooded . . . "It's the heaviest rain we've had in at least 10 years", said the observer at the U.S. Weather Station at the Greater Wilmington Airport.

June 23, 1972 - The maximum flow of record at both gages was caused by extremely heavy rainfall associated with Hurricane "Agnes." Floodwaters caused loss of life and millions of dollars worth of damage throughout the eastern United States.

EXCERPTS FROM THE WEEKLY POST, JUNE 28, 1972

THE WRATH OF AGNES [a]

Delaware was hit by the fury of Tropical Storm Agnes last week, but was actually one of the luckier states in the area. Despite wreckage depicted on this page[b] most damage was repairable. Unlike our neighboring states of Maryland and Pennsylvania, most residents of the state were able to return to their homes and begin the task of cleaning up within a short time.

Agnes is considered by many to be the worst storm ever to hit the Eastern United States, leaving thousands of people homeless and millions of dollars worth of damage in her wake. She decided not to make a lengthy stopover in Delaware on her travels northward. For that, we are grateful.

(a) Simulated from newspaper clippings
(b) Photograph not available

The following photographs of flooding on White Clay Creek appeared in the *WEEKLY POST* of June 28, 1972:

FIGURE 4 - A house on Red Mill Road is completely isolated by the floodwaters of White Clay Creek. Two young men are being rescued by members of local fire companies. (*WEEKLY POST* Staff Photograph by Eric Crossan.)

FIGURE 5 - Vehicles attempt to pass through the floodwaters of White Clay Creek that cover Chapel Street near the Curtis Paper Company. (Photograph by Everett.)

FUTURE FLOODS

Floods of the same or larger magnitude as those that have occurred in the past could occur in the future. Larger floods have been experienced in the past on streams with similar geographical and physiographical characteristics as those found in the study area. Similar combinations of rainfall and runoff which caused these floods could occur in the study area. Therefore, to determine the flooding potential of the study area, it was necessary to consider storms and floods that have occurred in regions of like topography, watershed cover and physical characteristics. Discussion of the future floods in this report is limited to those that have been designated as the Intermediate Regional Flood and the Standard Project Flood. The Standard Project Flood represents a reasonable upper limit of expected flooding in the study area. The Intermediate Regional Flood may reasonably be expected to occur more frequently although it will not be as severe as the infrequent Standard Project Flood. The estimates of the Intermediate Regional Flood and the Standard Project Flood as presented in this report are based on the existing development of the watershed since future changes within the basin cannot be accurately predicted.

Intermediate Regional Flood

The Intermediate Regional Flood (IRF) is defined as one that occurs once in 100 years on the average, although it could occur in any year. The peak flow of the Intermediate Regional Flood was developed from statistical analyses of streamflow records at the two U.S. Geological Survey gages located on White Clay Creek in the vicinity of Newark, Delaware, in conjunction with regional synthetic analyses at selected stations in the study area. Hurricane "Agnes" which occurred on June 23, 1972, was an extremely rare event on the upper portion of the White Clay Creek. The peak flow at U.S.G.S. Gage No. 4785 was approximately one and one half times the predicted 100-year flow. At U.S.G.S. Gage No. 4790, located further downstream, the peak flow was slightly less than the predicted 100-year flow. Peak flows thus developed for the Intermediate Regional Flood at selected locations are shown in Table 4. Relative water surface elevations for the Intermediate Regional Flood are shown on Plates 9 and 10.

Standard Project Flood

The Standard Project Flood is defined as a major flood that can be expected to occur from a severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the geographical area in which the study area is located, excluding extremely rare combinations. The Corps of Engineers, in cooperation with

the NOAA Weather Service, has made comprehensive studies and investigations based on the past records of experienced storms and floods and has developed generalized procedures for estimating the flood potential of streams. Table 4 shows the peak discharges for the Standard Project Flood at selected locations on White Clay Creek. Plates 9 and 10 represent the water surface elevations for the Standard Project Flood along White Clay Creek. Discharge hydrographs for the Standard Project Flood at each of the U.S. Geological Survey gaging stations on White Clay Creek are shown on Plate 13.

TABLE 4
PEAK FLOWS FOR INTERMEDIATE REGIONAL AND STANDARD PROJECT FLOODS

Location	River Mile	Drainage Area sq. mi.	Intermediate Regional Flood Discharge cfs	Standard Project Flood Discharge cfs
Confluence with Christina River	0.0	162.0	23,000	63,000
Above Confluence with Red Clay Creek	2.5	104.0	11,500	45,000
U.S.G.S. Gage No. 4790, East of Newark	5.2	87.8	10,500	40,800
U.S.G.S. Gage No. 4785, North of Newark	12.5	66.7	6,700	33,600
Pennsylvania-Delaware State Line	14.7	60.0	6,200	29,600

Table 5 shows comparisons of flood elevations for the Intermediate Regional Flood and the Standard Project Flood with the highest known floods at stream gage No. 4790, east of Newark, Delaware.

TABLE 5
FLOOD ELEVATIONS
(U.S.G.S. Gaging Station No. 4790, East of Newark)

Flood	Elevation ft.-m.s.l.d.
Standard Project	41.6
Intermediate Regional	30.9
July 5, 1937	34.6(a)
June 23, 1972	29.3
August 10, 1967	28.0
September 12, 1960	27.7

(a) Affected by backwater from bridge constriction downstream of gage

Frequency

A frequency curve of peak flows was constructed on the basis of available information and computed flows of floods up to the magnitude of the Intermediate Regional Flood. The frequency curve thus derived, which is available on request, reflects the judgment of engineers who have studied the area and are familiar with the region; however, it must be regarded as approximate and should be used with caution in connection with any planning of flood plain use. Floods larger than the Standard Project Flood are possible but the combination of factors necessary to produce such large flows would be extremely rare.

Hazards of Large Floods

The extent of damage caused by any flood depends on the topography of the area flooded, depth and duration of flooding, velocity of flow, rate of rise, and developments in the flood plain. An Intermediate Regional Flood or Standard Project Flood on the White Clay Creek would result in the inundation of residential, commercial and industrial properties in the study area. Floodwaters at high velocities carrying floating debris can create hazardous conditions to persons and vehicles in flooded areas. In general, floodwater 3 or more feet deep and flowing at a velocity of 3 or more feet per second could easily sweep an adult person off his feet, thus creating definite danger of injury or drowning. Rapidly rising and swiftly flowing floodwater may trap persons in homes that are ultimately destroyed, or in vehicles that are ultimately submerged or carried away. Waterlines can be ruptured by heavy deposits of debris and the force of floodwaters, creating the possibility of contaminated domestic water supplies. Damaged sanitary sewer lines and sewage treatment plants could result in the pollution of floodwaters creating health hazards. High and turbulant floodwaters can isolate areas during emergencies, hindering medical, fire and law enforcement agencies.

Flooded areas and flood damages - The areas along the White Clay Creek that would be inundated by the Standard Project flood are shown on Plate 2, which is also an index map to Plates 3 through 8. Areas that would be flooded by the Intermediate Regional and Standard Project Floods are shown in detail on Plates 3 through 8. The actual limits of these overflow areas may vary somewhat from those shown on the maps because the contour interval and scale of the maps do not permit precise plotting of the flooded area boundaries. The highest stages of flooding throughout the study area occur in the lower basin when floodwaters of the White Clay and Red Clay Creeks combine with high stages of the Christina River. The areas that would be flooded by the Intermediate Regional and Standard Project Floods include commercial, industrial, and residential sections along with streets, roads, and private and public utilities near White Clay Creek. Considerable damage to these facilities would occur during an Intermediate Regional Flood. However, due to the wider extent; greater depths of flooding, higher velocity flow and longer duration of flooding during a Standard Project Flood, damage would even be more severe than during an Intermediate Regional Flood.

Plates 9 and 10 show the high water profiles of the Intermediate Regional Flood and the Standard Project Flood. Also indicated are the major bridges and dams crossing White Clay Creek and the level of flooding at these structures. Using these structures as a location guide, the expected high water elevations reached by the Intermediate Regional and Standard Project Floods at any site along the stream can be found. The profile of the stream bed represents the lowest elevation at any stream location. Water depth in the channel is the difference between the high water elevation and stream bed elevation. Selected cross sections shown on Plates 11 and 12 describe the lateral extent of the Intermediate Regional Flood and the Standard Project Flood. The lowest point of the ground line is the stream bed elevation indicated on the profiles.

Obstructions - During floods, debris collecting on bridges and culverts could decrease their carrying capacity, causing greater water depths (backwater effect) upstream of these structures. As the occurrence and amount of debris are indeterminate factors, only the physical characteristics of the structures were considered in preparing profiles of the Intermediate Regional and Standard Project Floods. Similarly, the maps of flooded areas show the backwater effect of obstructive bridges and culverts, but do not reflect increased water surface elevations that could be caused by debris accumulation against the structures, or by silt deposits in the stream channel under structures. The 5 dams within the study area have no flood control capacities and will not seriously alter flow characteristics of floodwaters. Of the 12 bridges crossing the White Clay Creek in the study area, 7 are obstructive to the Intermediate Regional Flood while all are obstructive to the Standard Project Flood. Table 6 shows water surface elevations at these bridges.

TABLE 6
ELEVATION DATA
Bridges Across White Clay Creek

Identification	Mileage Above Mouth	Underclearance Elevation ft.-m.s.l.d.	Water Surface Elevation	
			Intermediate Regional Flood ft.-m.s.l.d.	Standard Project Flood ft.-m.s.l.d.
Penn Central R.R.	2.3	10.4	20.0	22.3
Private Rd.	2.4	11.1	20.1	22.8
Wilmington-Christina Pike (Del. Rt. 7)	2.9	12.9	20.3	23.6
Penn Central R.R. Spur to Delaware Park Race Track	3.1	23.5	21.5	27.7
Delaware Park Access Rd.	4.4	26.7	24.9	33.8
Baltimore & Ohio R.R.	5.1	29.3	29.0	41.5
Harmony Rd.	5.9	31.8	35.0	45.6
Red Mill Rd.	7.4	41.9(a)	41.6	53.8
Kirkwood Highway (Del. Rt. 2)	8.6	61.9(a)	51.0	64.4
Chapel St. (Del. Rt. 72)	10.2	67.4(a)	69.8	82.2
Hopkins Rd.	13.3	100.8	101.8	113.2
Chambers Rock Rd.	14.2	103.9	106.6	117.0

(a) Average low steel.

Velocities of flow - During floods, water is forced to pass over lands not normally inundated, causing a wide range of velocities to occur. The water flowing in the deeper portions of the stream channel will be faster than in the more shallow overbank areas. Velocities of flow will also vary from one location upstream to the next area downstream as stream characteristics change. Some important factors are changes in bed slope, size and shape of channel and overbank areas, vegetation cover, materials composing the stream bed, and increased volumes of water to be carried by the stream possibly coming from tributaries, or direct storm runoff. Soil will be eroded by velocities more swift than 2 feet per second while debris and silt will be deposited at slower velocities. For the same location, it is possible to have severe erosion of the stream banks occur simultaneously with deposition of alluvial soils on the flood plain.

Table 7 lists average velocities which would occur during peak flows for the Intermediate Regional and the Standard Project Floods at selected locations along White Clay Creek. The velocities which would occur during a Standard Project Flood are notably faster because the volume of water which must be carried by the stream is greater than that for an Intermediate Regional Flood.

The lower reach of White Clay Creek from the confluence with Red Clay Creek to Christina River is affected by large floods on the Christina River, which create large ponding areas of slow-moving water at high flood stages. These high stages can reduce velocities in White Clay Creek even for large floodflows. However, a flood could occur on White Clay Creek independently of Christina River in which case velocities in the lower reaches would be faster than those given in Table 7 and the depth of water would be more shallow, making the extent of flooding less severe.

TABLE 7
MAXIMUM VELOCITIES ON WHITE CLAY CREEK

Location	Intermediate Regional Flood		Standard Project Flood	
	Main Channel ft./sec.	Overbank ft./sec.	Main Channel ft./sec.	Overbank ft./sec.
Confluence with Christina River	1.2	0.4	1.9	0.6
Above Confluence with Red Clay Creek	1.4	0.4	4.2	1.7
U.S.G.S. Gage No. 4790, East of Newark	4.2	0.8	10.5	2.5
U.S.G.S. Gage No. 4785, North of Newark	6.7	1.0	12.0	2.6
Pennsylvania-Delaware State Line	6.8	1.6	11.8	3.2

Rates of rise and duration of flooding - Intense rainfalls that accompany severe storm fronts usually produce the floods occurring in the White Clay Creek Watershed. The stream channel contains flows for varying time intervals before overbank flooding occurs. Once overbank flooding occurs, the water rises at a rate of about 1 to 3 feet per hour. Floodwaters can remain out of banks for time periods up to a day. Table 8 gives the maximum rate of rise (above critical stage), height of rise (from critical stage to maximum flood level), time of rise (time period corresponding to height of rise), and duration of critical stage (period of time flooding is above critical stage level) for the Standard Project Flood and three floods recorded at the U.S. Geological Survey gage east of Newark, Delaware.

TABLE 8
RATES OF RISE AND DURATION
(U.S.G.S. Gaging Station No. 4790, East of Newark)

Flood	Maximum Rate of Rise ft./hr.	Height of Rise ft.	Time of Rise hrs.	Duration of Critical Stage hrs.
Standard Project	3.0	17.0	8.5	23.2
June 23, 1972	1.2	4.7	8.3	14.3
August 10, 1967	1.6	3.4	2.5	10.0
September 12, 1960	0.9	3.1	4.0	14.5

Photographs, future flood heights - The levels that the Intermediate Regional and Standard Project Floods are expected to reach at various locations along White Clay Creek are indicated on the following photographs.

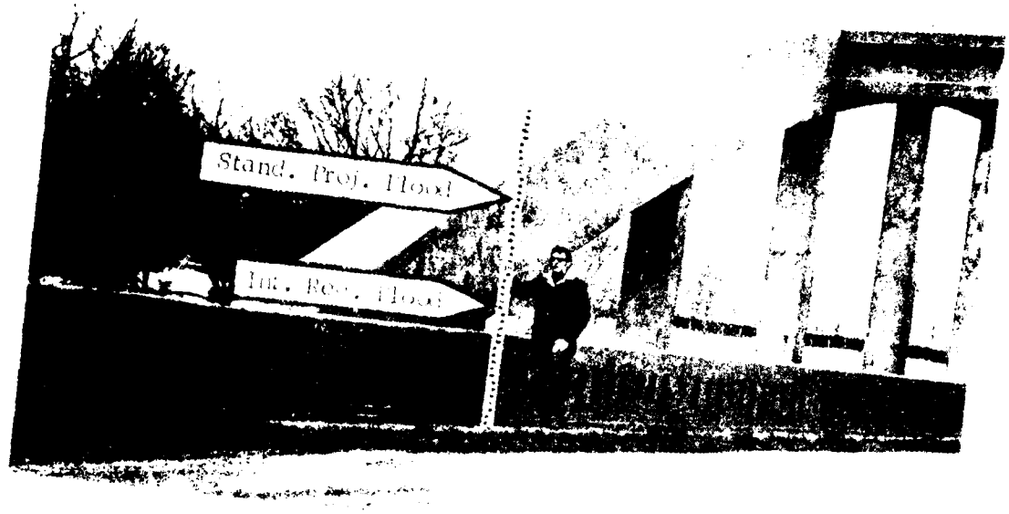


FIGURE 6 - Future flood heights on Del. Rt. 7 near the entrance to Delaware Park Race Track.

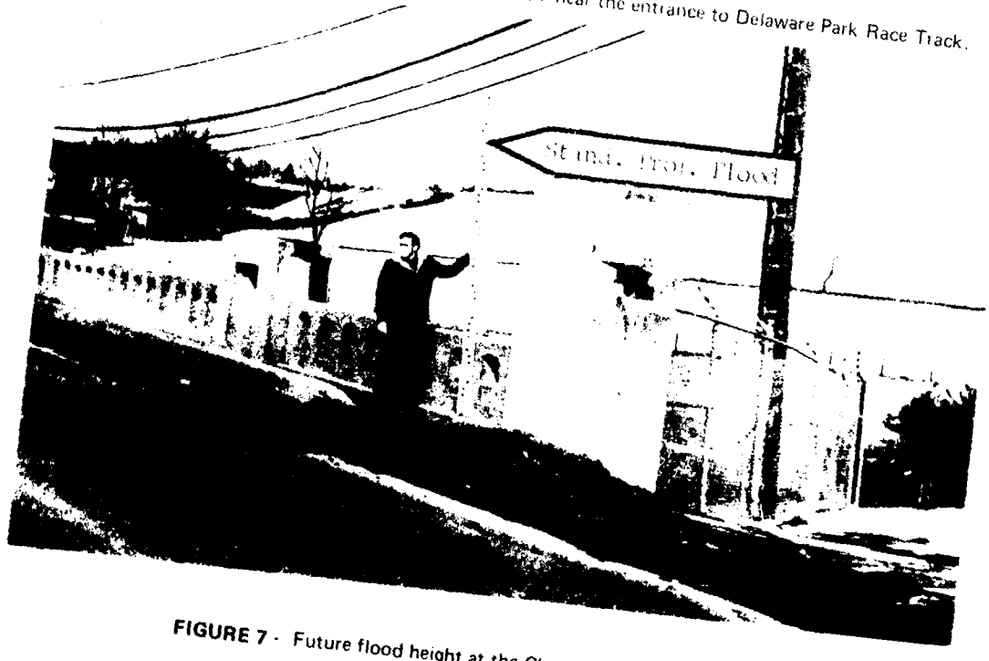


FIGURE 7 - Future flood height at the Chapel St. (Del. Rt. 72) bridge.

FIGURE 8 - Future flood heights at Lowe's of Wilmington located on Wilmington-Christina Pike (Del. Rt. 7)

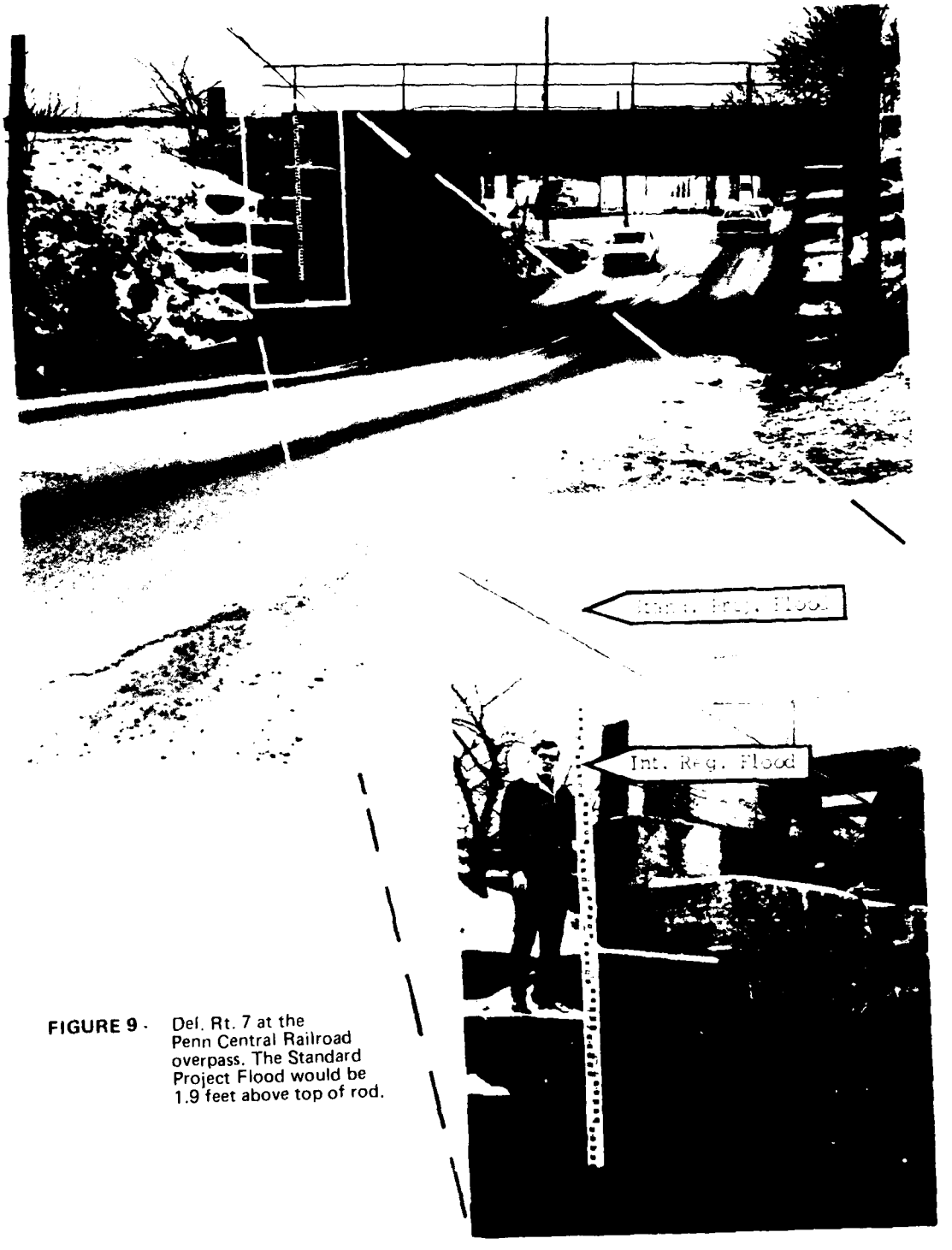


FIGURE 9 - Del. Rt. 7 at the Penn Central Railroad overpass. The Standard Project Flood would be 1.9 feet above top of rod.

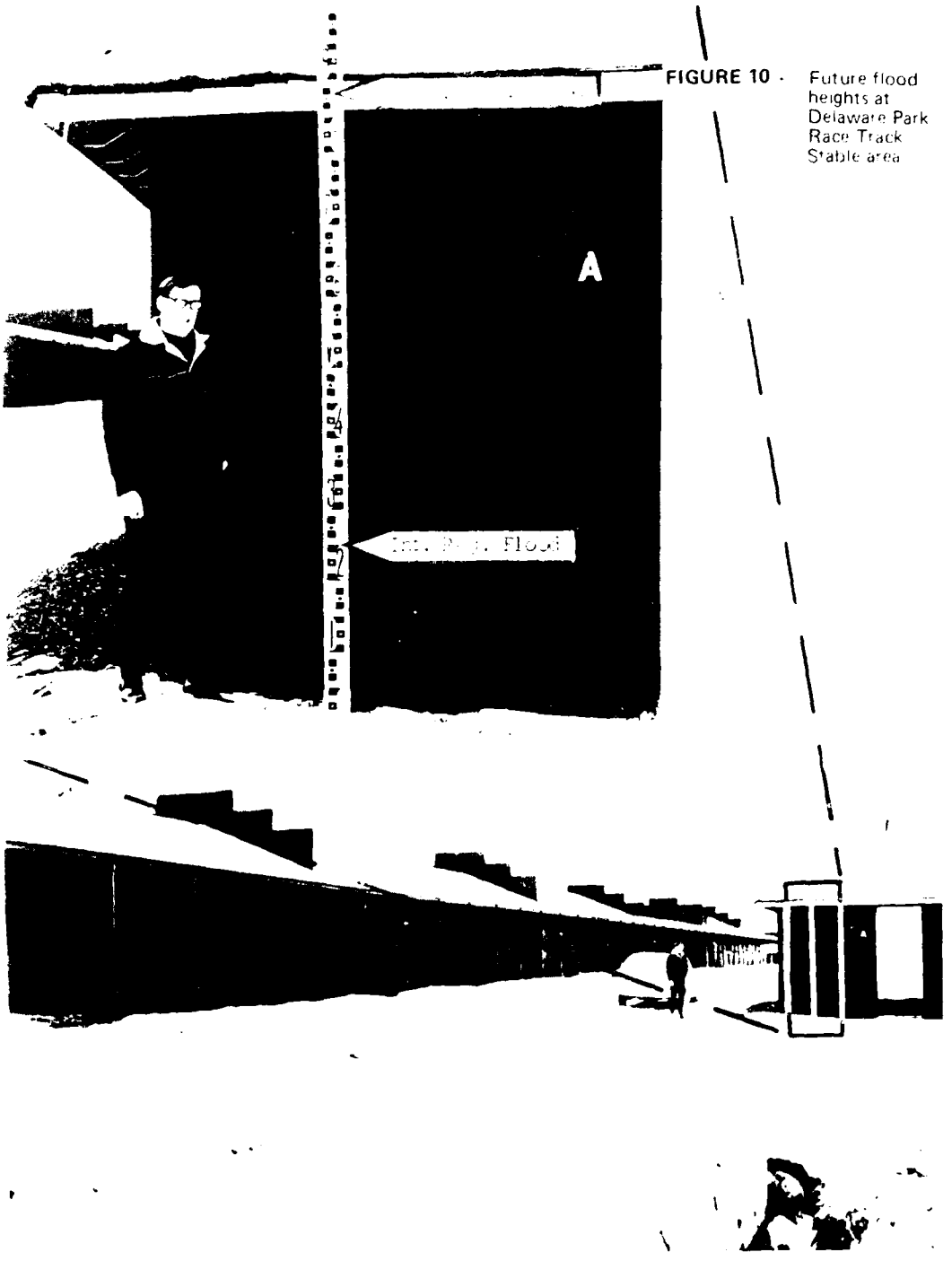


FIGURE 10 - Future flood heights at Delaware Park Race Track Stable area

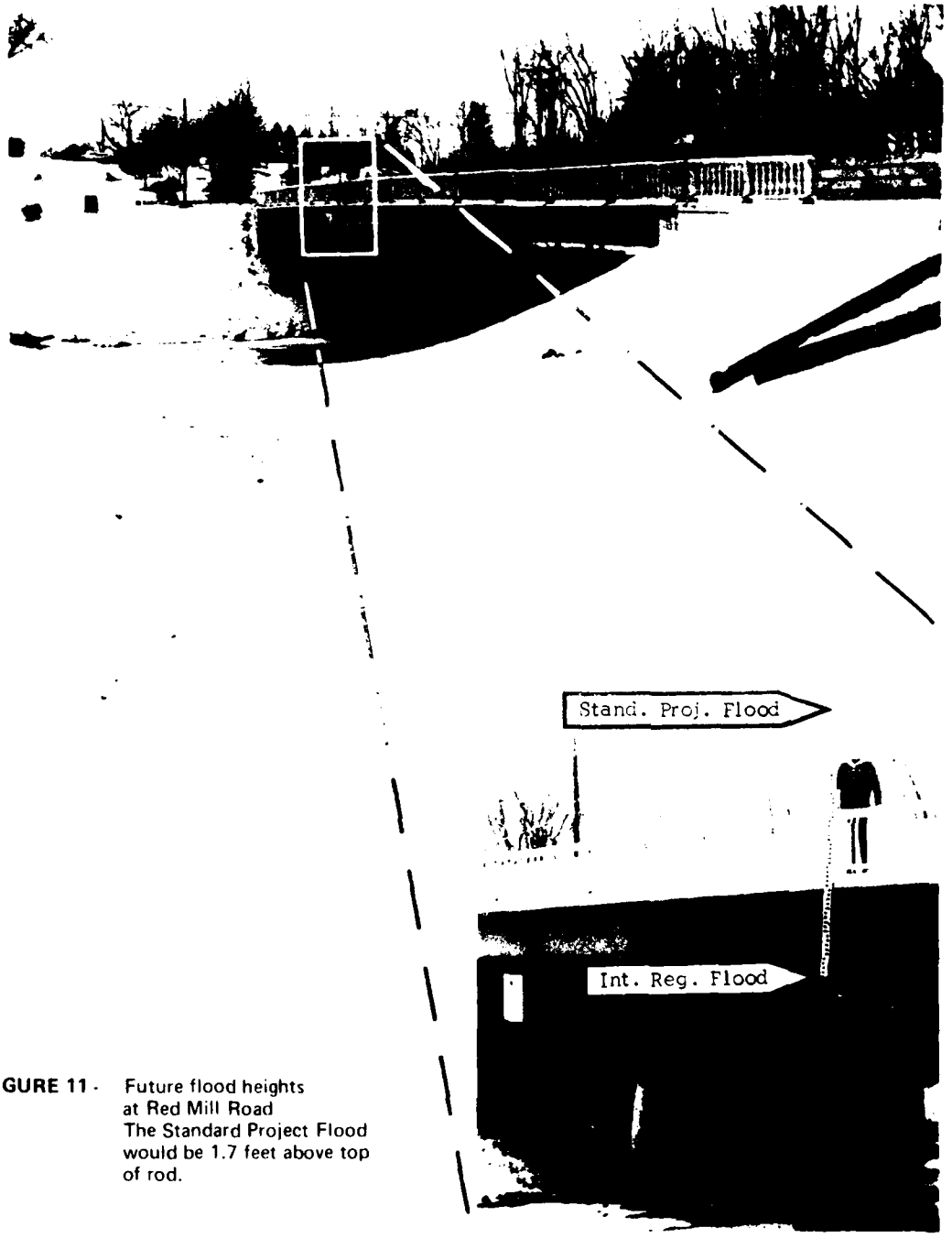


FIGURE 11 - Future flood heights at Red Mill Road
The Standard Project Flood would be 1.7 feet above top of rod.

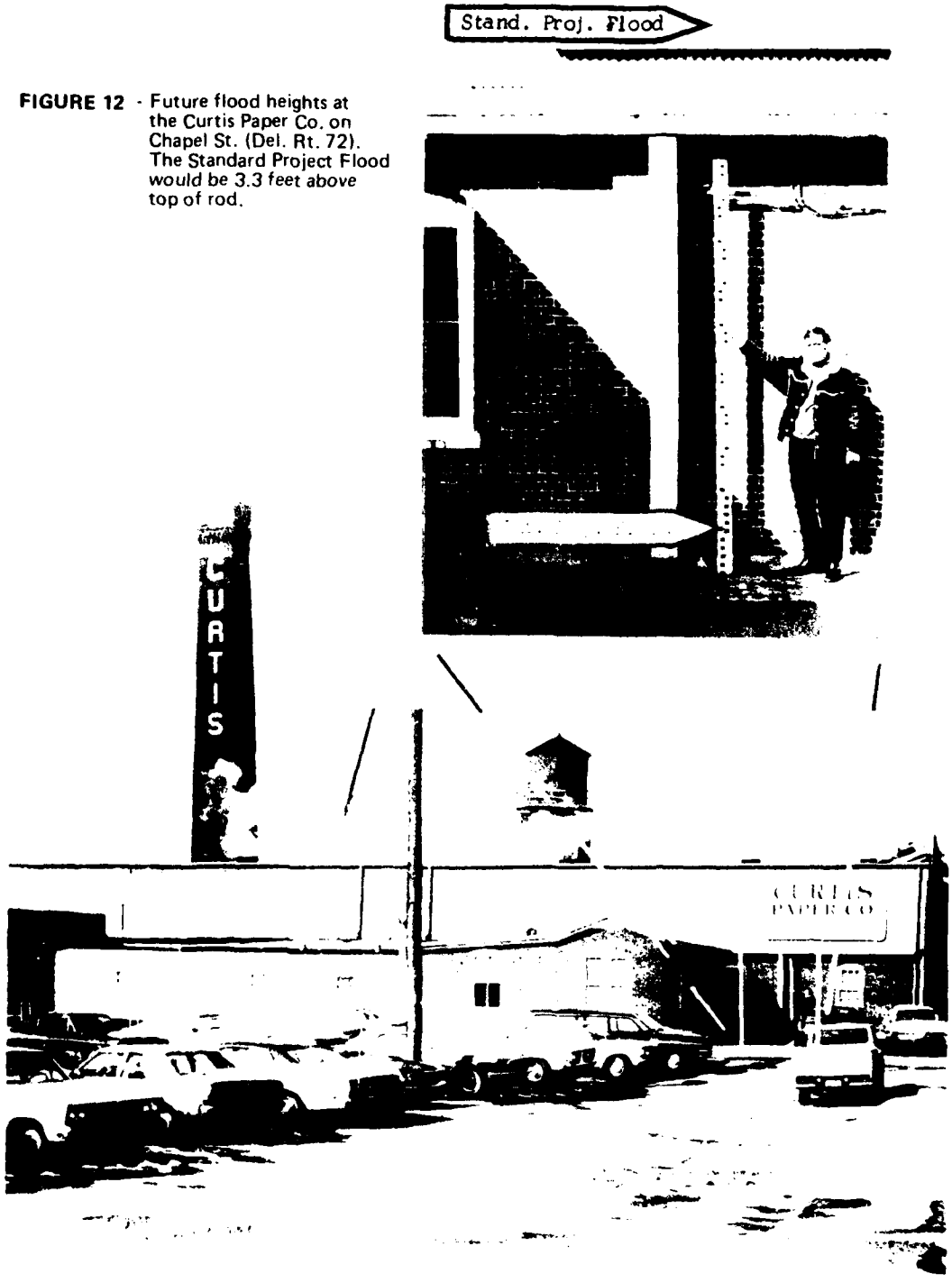


FIGURE 12 - Future flood heights at the Curtis Paper Co. on Chapel St. (Del. Rt. 72). The Standard Project Flood would be 3.3 feet above top of rod.

GLOSSARY

Critical Stage. The point at which floodflows overtop the natural or artificial banks along any reach of a stream.

Critical Stage Level. The elevation that corresponds to critical stage.

Flood. An overflow of lands not normally covered by water and that are used or usable by man. Floods have two essential characteristics: The inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river, stream, ocean, lake, or other body of standing water.

Normally a "flood" is considered as any temporary rise in streamflow or stage, but not the ponding of surface water, that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow of land areas, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions or other unfavorable situations by deposition of materials in stream channels during flood recessions, rise of ground water coincident with increased streamflow, and other problems.

Flood Crest. The maximum stage or elevation reached by the waters of a flood at a given location.

Flood Peak. The maximum instantaneous discharge of a flood at a given location. It usually occurs at or near the time of the flood crest.

Flood Plain. The relatively flat area or lowlands adjoining a river, stream, watercourse, ocean, lake, or other body of standing water that have been or may be covered by floodwater.

Flood Profile. A graph showing the relationship of water surface elevation to location, the latter generally expressed as distance above mouth for a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood, but may be prepared for conditions at a given time or stage.

Flood Stage. The stage or elevation at which overflow of the natural banks of a stream or body of water begins in the reach or area in which the elevation is measured.

Intermediate Regional Flood. A flood having a frequency of occurrence in the order of once in 100 years although the flood may occur in any year. It is based on statistical analyses of streamflow records available for the watershed and analyses of rainfall and runoff characteristics in the general region of the watershed.

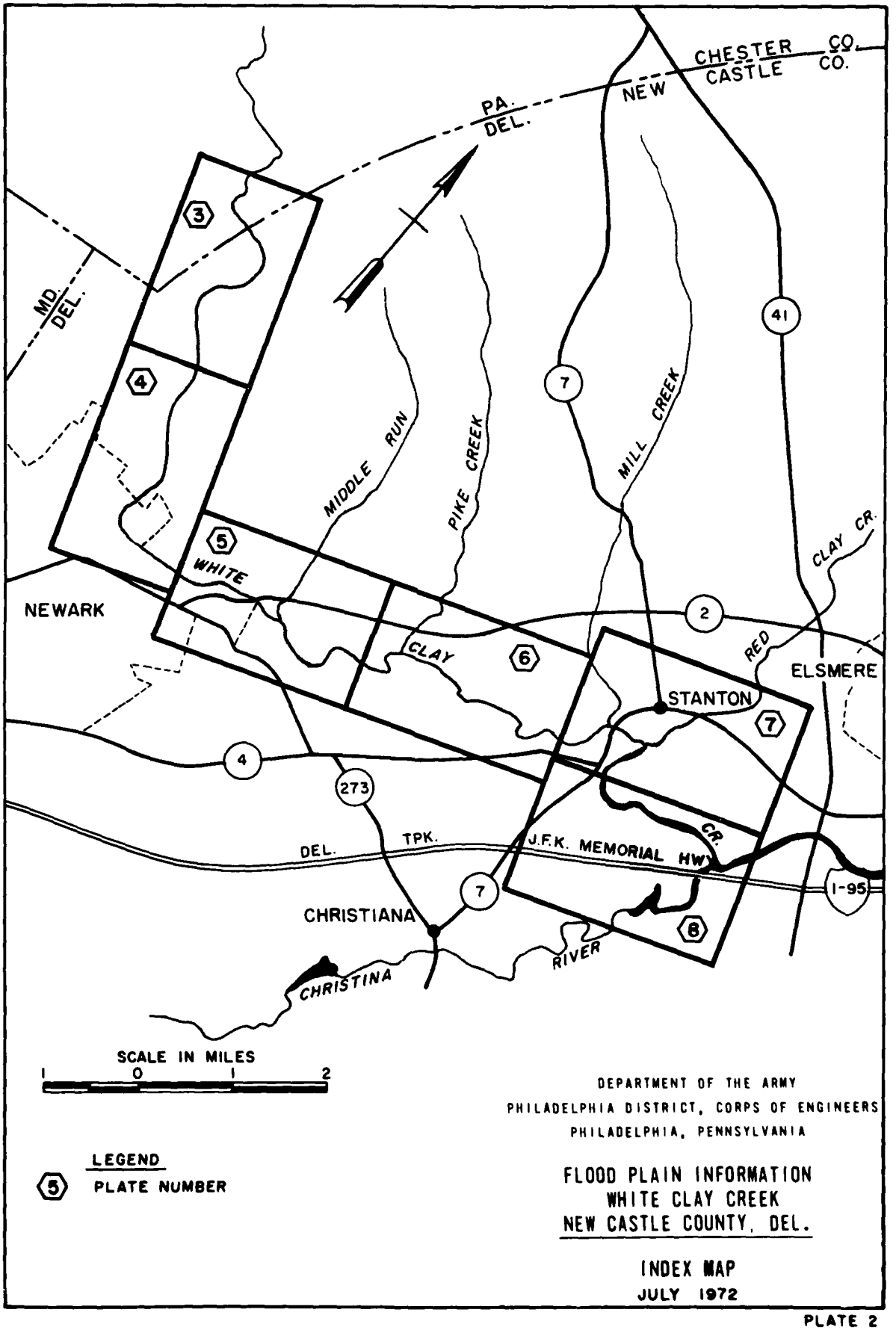
Left Bank. The bank on the left side of a river, stream, or watercourse, looking downstream.

Right Bank. The bank on the right side of a river, stream, or watercourse, looking downstream.

Standard Project Flood. The flood that may be expected from the most severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the geographical area in which the drainage basin is located, excluding extremely rare combinations. Peak discharges for these floods are generally about 40-60 percent of the Probable Maximum Floods for the same basins. As used by the Corps of Engineers, Standard Project Floods are intended as practicable expressions of the degree of protection that should be sought in the design of flood control works, the failure of which might be disastrous.

Thunderstorm. A high intensity, convective type rainstorm of short duration that is characterized by extremely heavy rainfall. As used in this report, "cloudburst" and "thunderstorm" are essentially synonymous.

Underclearance Elevation. The elevation at the top of the opening of a culvert, or other structure through which water may flow along a watercourse.

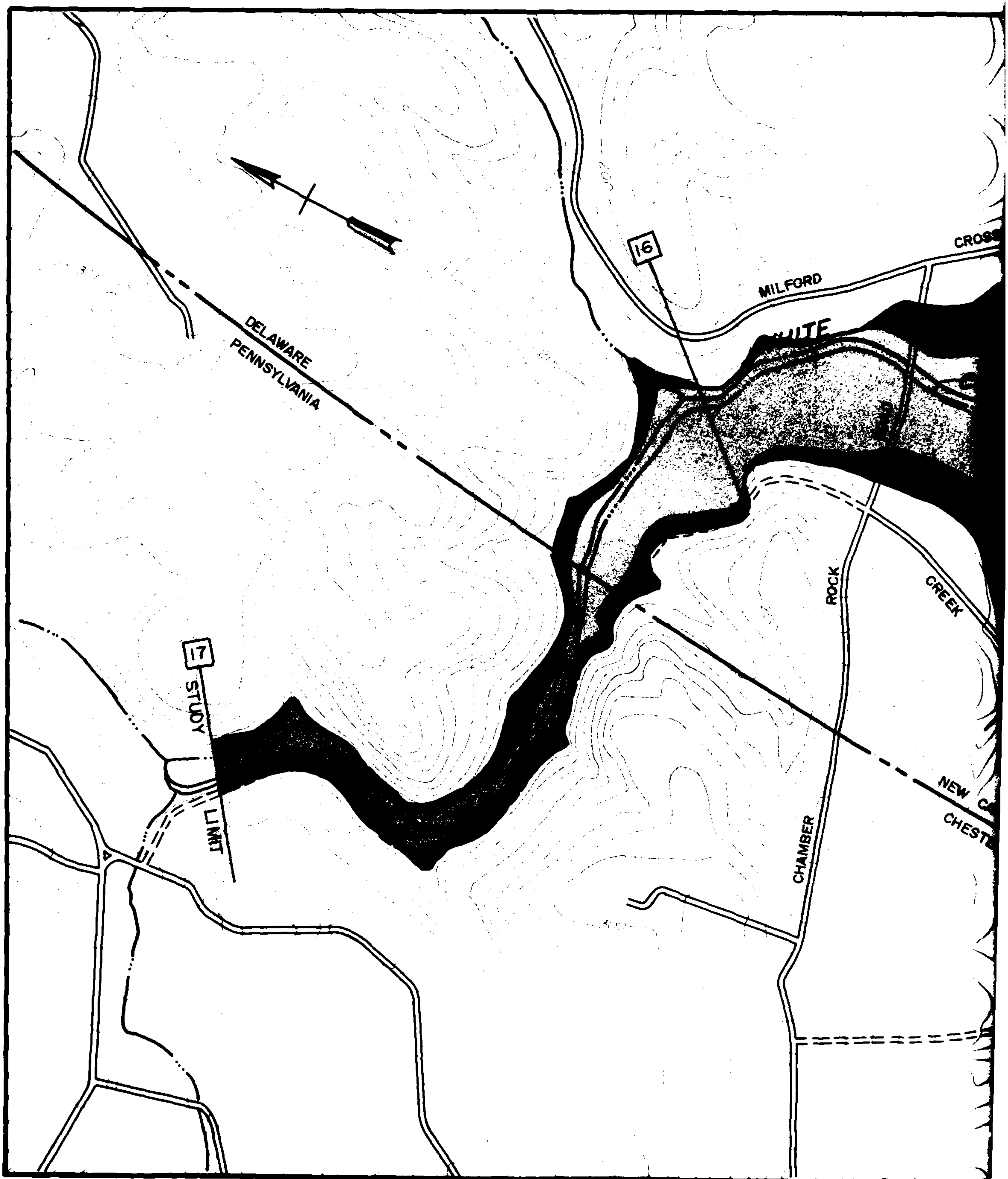


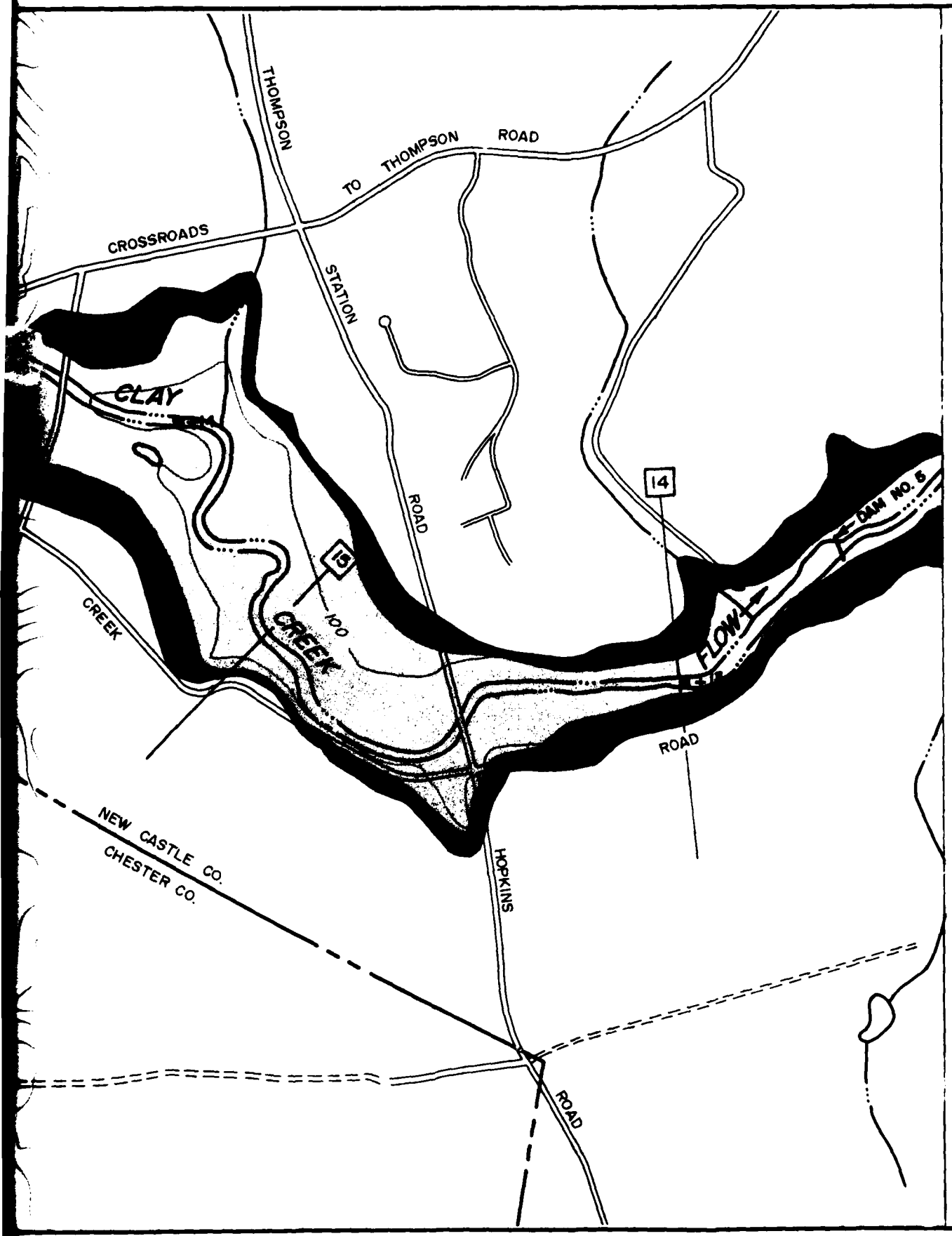
DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

FLOOD PLAIN INFORMATION
WHITE CLAY CREEK
NEW CASTLE COUNTY, DEL.

INDEX MAP
JULY 1972

PLATE 2


16
MILFORD
CROSS
DELAWARE
PENNSYLVANIA
17
STUDY
LIMIT
ROCK
CREEK
CHAMBER
NEW
CHESTE



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INTI
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FLO

M+15 MIL

16 CRO

GRO
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NOTES

1. MAP BASED ON U.
SHEETS NEWARK
NEWARK EAST, DE
DEL.-N.J. 1967.
ADJUSTMENTS MA

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THE REPORT.

3. AREAS OUTSIDE
SUBJECT TO FLO

4. MINIMUM CONTOU

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WH
NEW CA

FL

MATCH LINE PLATE 4

LEGEND

OVERFLOW LIMITS

INTERMEDIATE REGIONAL FLOOD — STANDARD PROJECT FLOOD

M+15 MILES ABOVE MOUTH

16 CROSS SECTION

GROUND ELEVATION IN FEET (U.S.C.& G.S. 1929 ADJ.) SEA LEVEL DATUM

CHANNEL

CITY OR BORO LIMITS

NOTES

1. MAP BASED ON U.S.G.S. 7.5 MIN. QUADRANGLE SHEETS NEWARK WEST, MD.-DEL.-PA., 1953, NEWARK EAST, DEL., 1953 & WILMINGTON SOUTH, DEL.-N.J. 1967. MINOR ADDITIONS AND ADJUSTMENTS MADE BY CORPS OF ENGINEERS.
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3. AREAS OUTSIDE THE FLOOD PLAIN MAY BE SUBJECT TO FLOODING FROM LOCAL RUNOFF.
4. MINIMUM CONTOUR INTERVAL IS 20 FT.

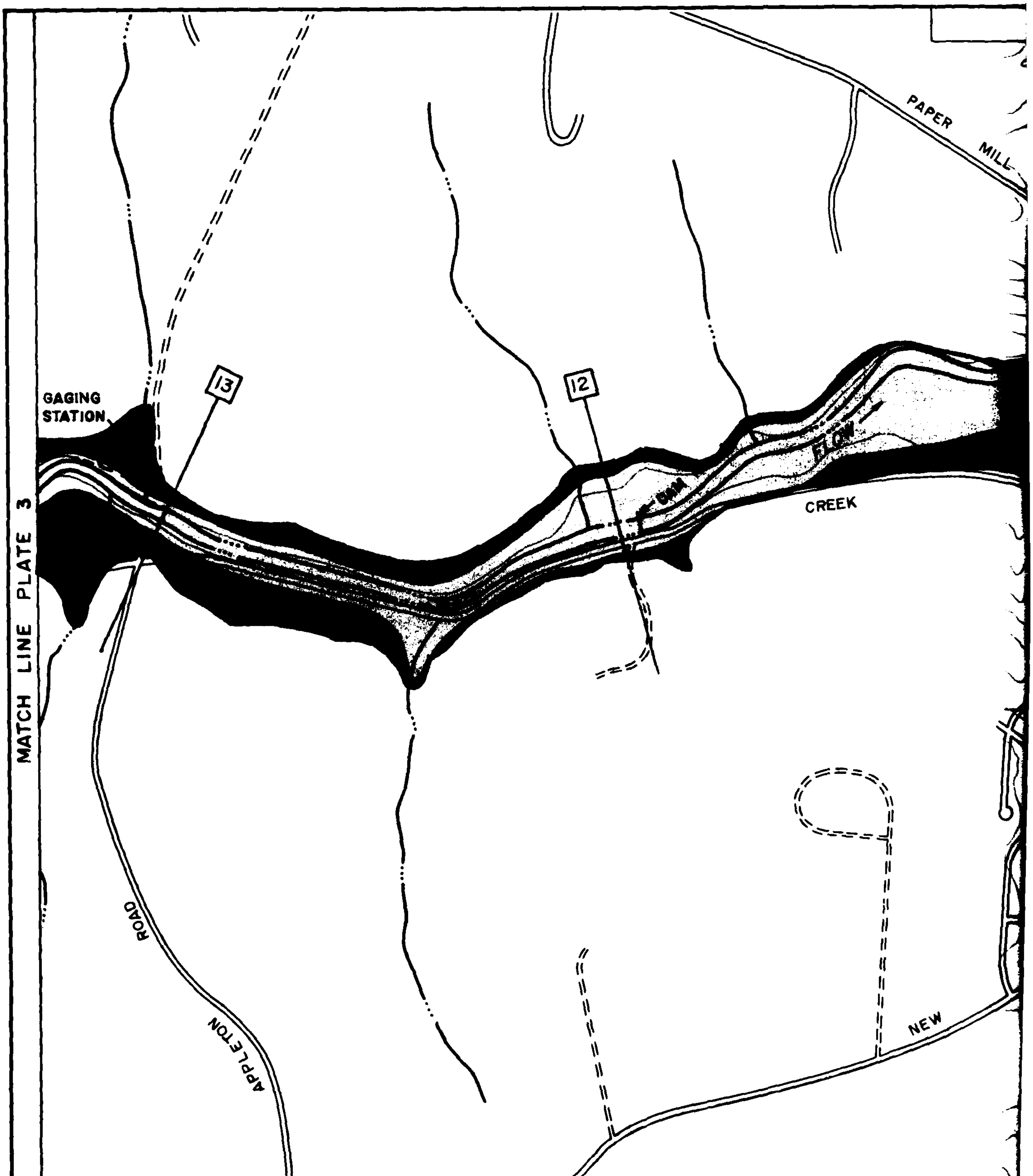
SCALE IN FEET

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

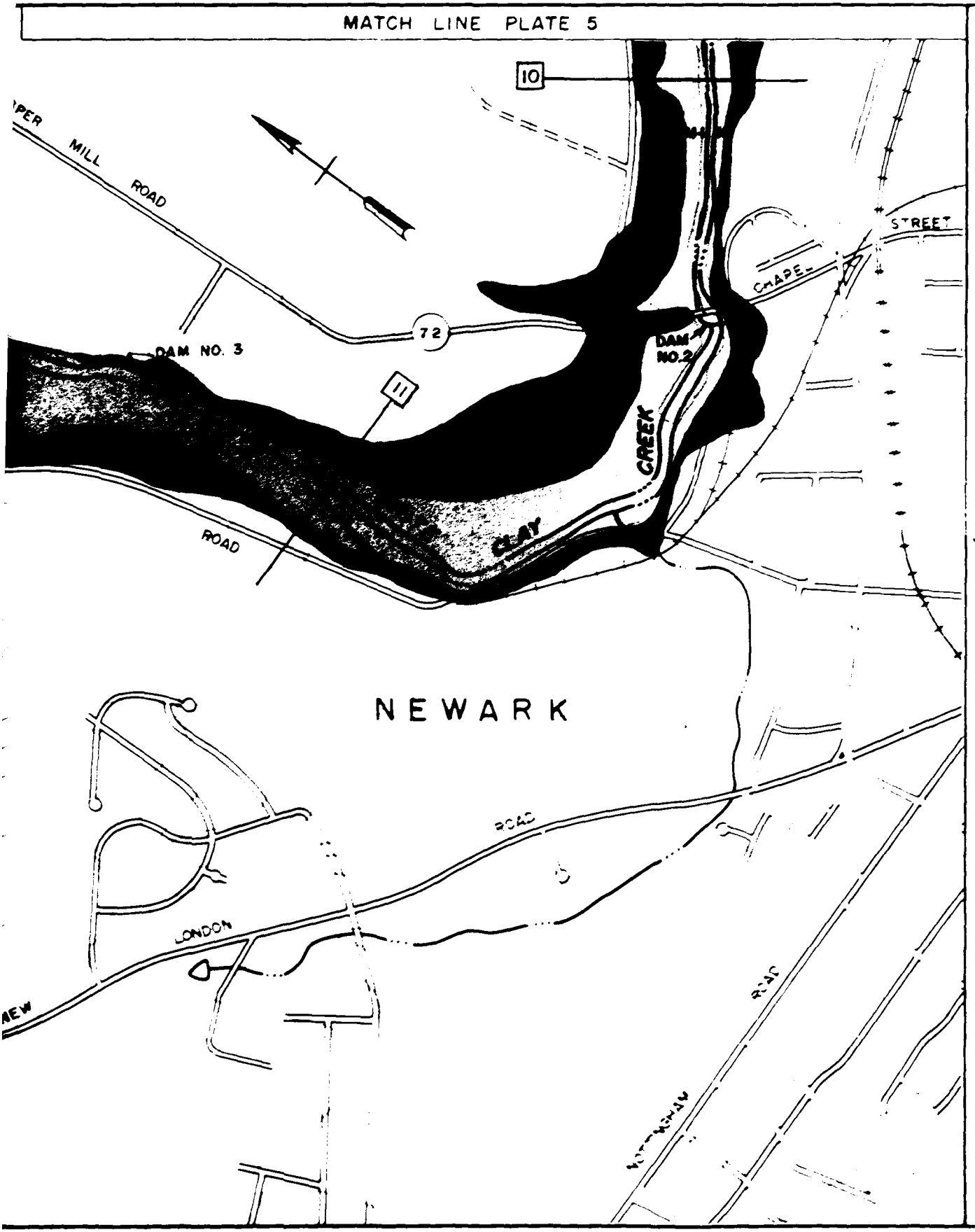
FLOOD PLAIN INFORMATION
WHITE CLAY CREEK
NEW CASTLE COUNTY, DEL.

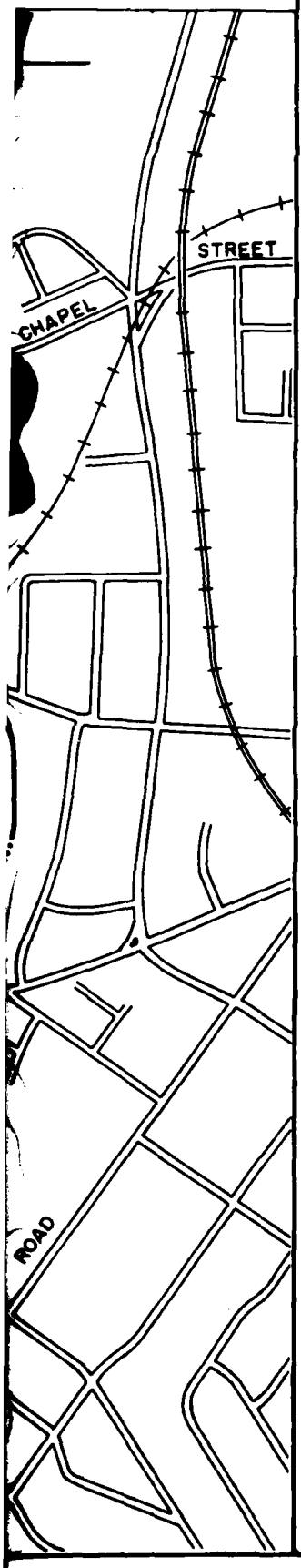
FLOODED AREAS
JULY 1972

PLATE 3



MATCH LINE PLATE 3
GAGING STATION
13
12
DAM
FLOW
CREEK
PAPER
MILL
ROAD
APPLETON
NEW


MATCH LINE PLATE 5
10
MILL
ROAD
72
DAM NO. 3
11
ROAD
CLAY
CREEK
DAM NO. 2
CHAPE
STREET
NEWARK
ROAD
LONDON
ROAD



LEGEND

OVERFLOW LIMITS

INTERMEDIATE REGIONAL FLOOD — STANDARD PROJECT FLOOD

M+12 MILES ABOVE MOUTH

12 CROSS SECTION

GROUND ELEVATION IN FEET (U.S.C.& G.S. 1929 ADJ.) SEA LEVEL DATUM

CHANNEL

CITY OR BORO LIMITS

NOTES

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4. MINIMUM CONTOUR INTERVAL IS 20 FT.

SCALE IN FEET

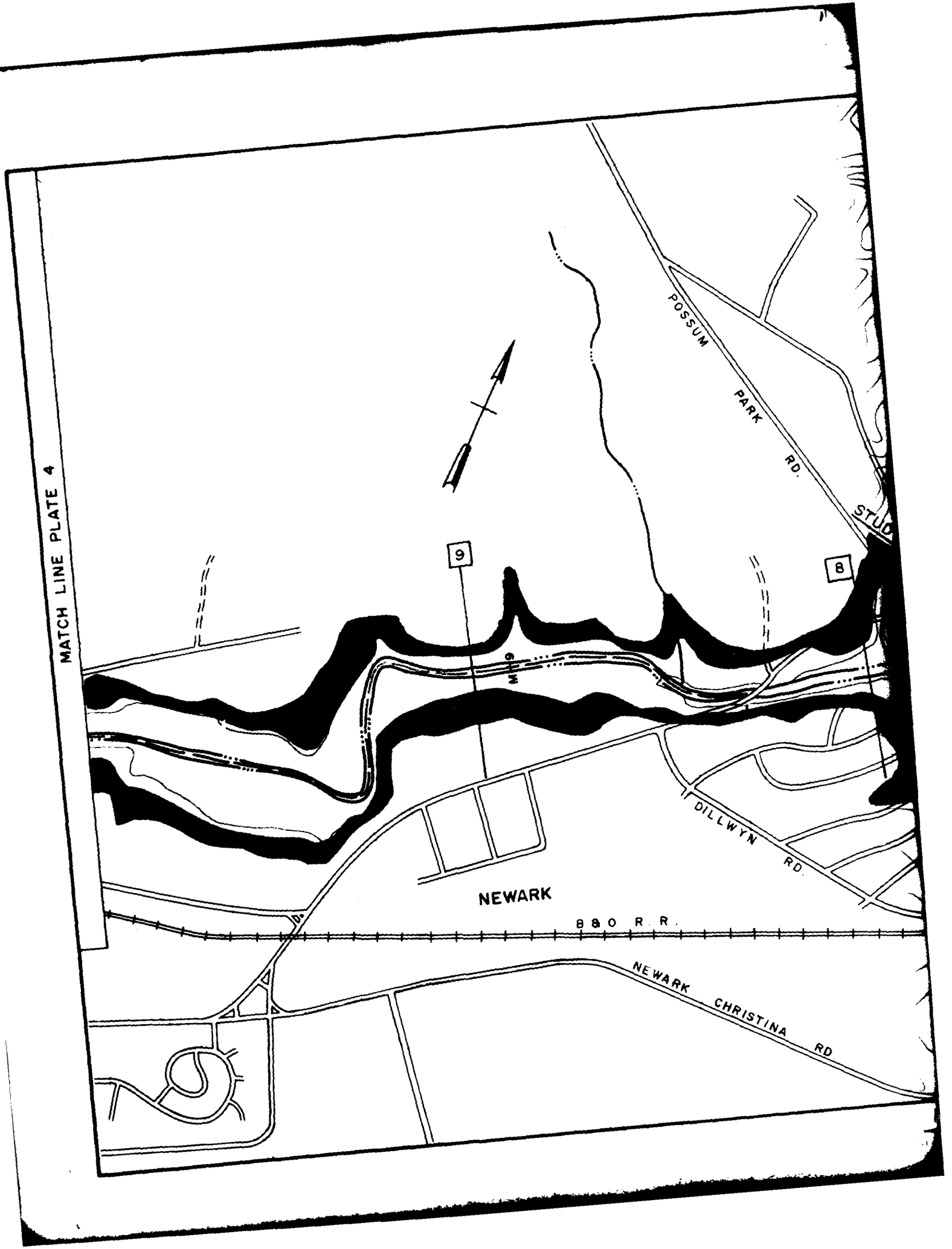
0 800 1600

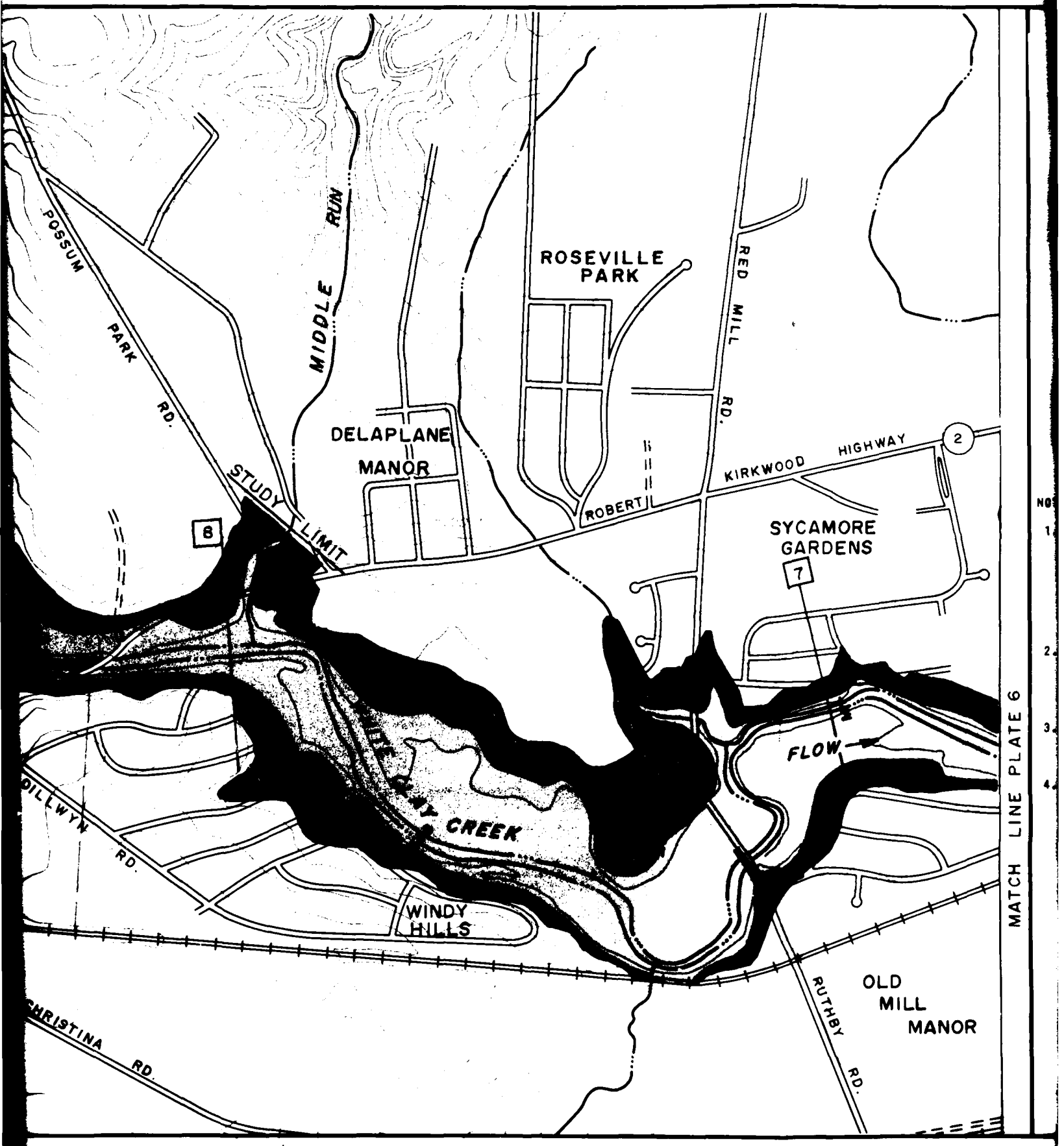
DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

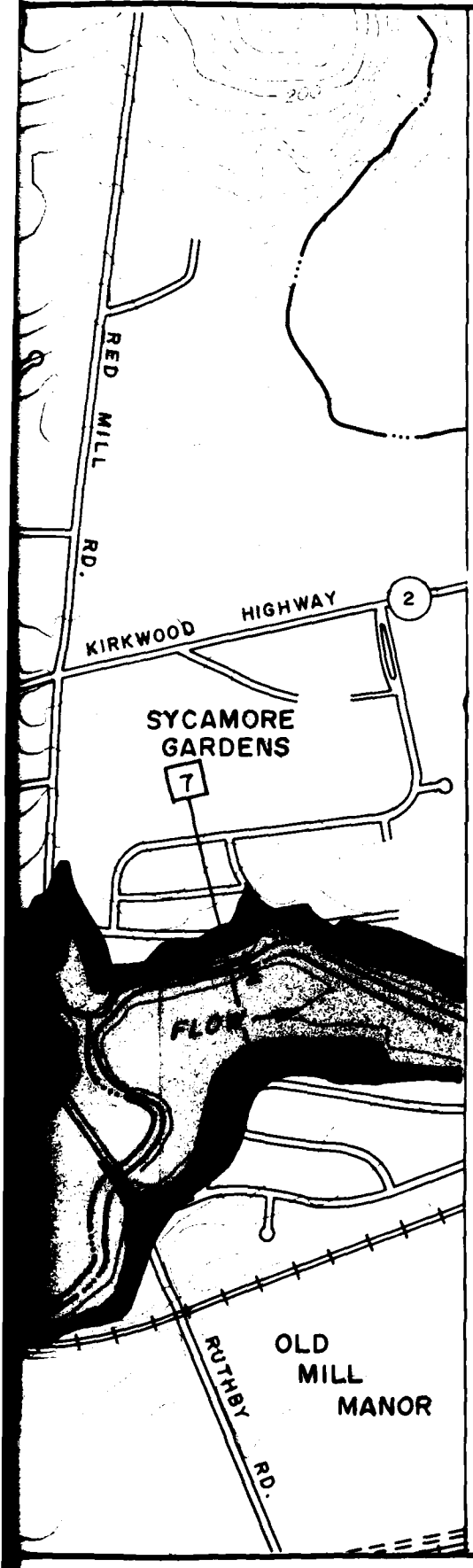
FLOOD PLAIN INFORMATION
WHITE CLAY CREEK
NEW CASTLE COUNTY, DEL.

FLOODED AREAS
JULY 1972

PLATE 4


MATCH LINE PLATE 4
POSSUM PARK RD.
9
8
DILLWYN RD.
NEWARK
B&O R.R.
NEWARK CHRISTINA RD


POSSUM PARK RD.
MIDDLE RUN
ROSEVILLE PARK
RED MILL RD.
DELAPLANE MANOR
KIRKWOOD HIGHWAY
2
ROBERT
STUDY LIMIT
8
SYCAMORE GARDENS
7
FLOW
CREEK
OILLWYN RD.
WINDY HILLS
OLD MILL MANOR
RUTHBY RD.
CHRISTINA RD.
MATCH LINE PLATE 6
NO
1
2
3
4



LEGEND

OVERFLOW LIMITS

INTERMEDIATE REGIONAL FLOOD — STANDARD PROJECT FLOOD

M+9 MILES ABOVE MOUTH

9 CROSS SECTION

GROUND ELEVATION IN FEET (U.S.C.& G.S. 1929 ADJ.) SEA LEVEL DATUM

CHANNEL

CITY OR BORO LIMITS

NOTES

1. MAP BASED ON U.S.G.S. 7.5 MIN. QUADRANGLE SHEETS NEWARK WEST, MD.-DEL.-PA., 1953, NEWARK EAST, DEL., 1953 & WILMINGTON SOUTH, DEL.-N.J. 1967. MINOR ADDITIONS AND ADJUSTMENTS MADE BY CORPS OF ENGINEERS.
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4. MINIMUM CONTOUR INTERVAL IS 10 FT.

SCALE IN FEET

0 800 1600

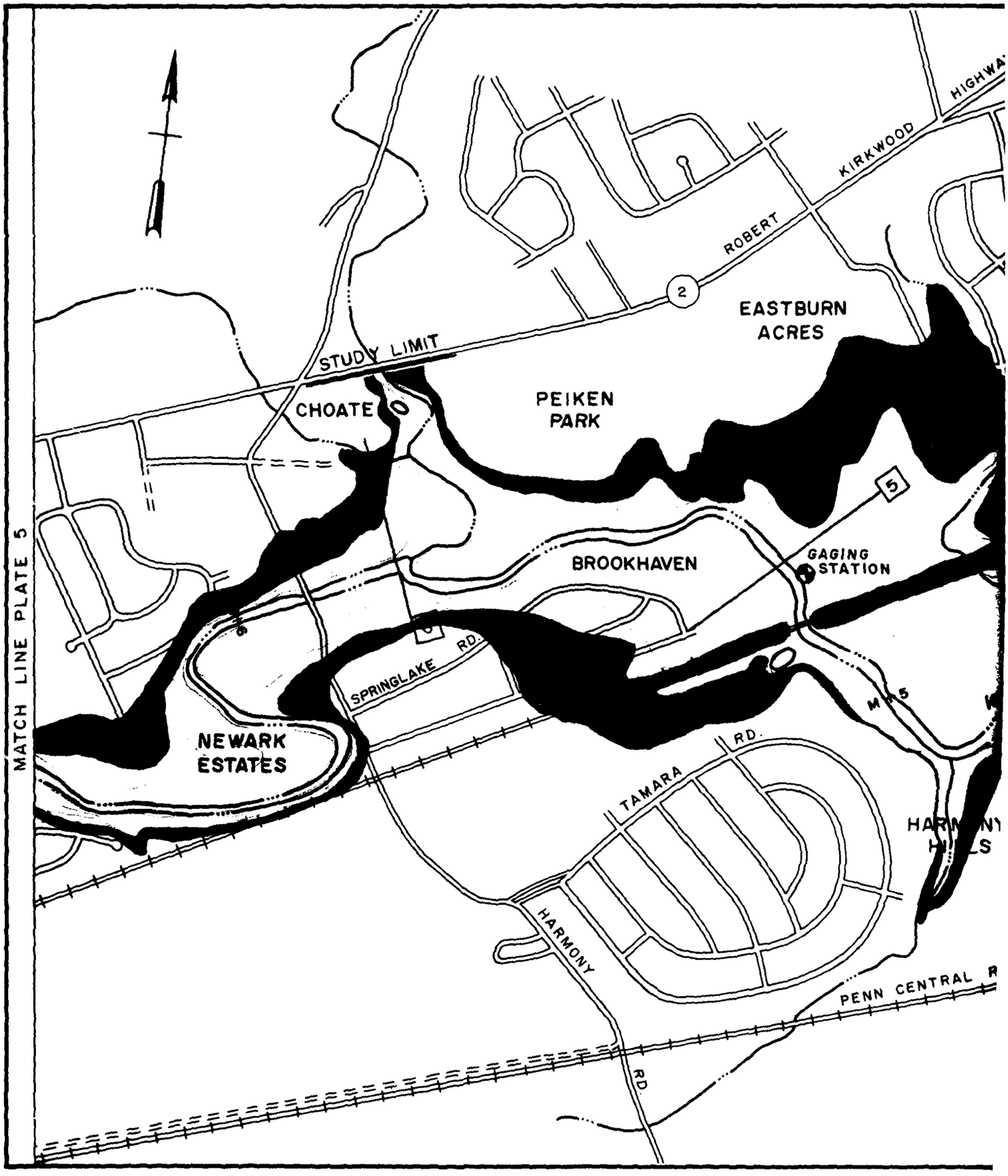
DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

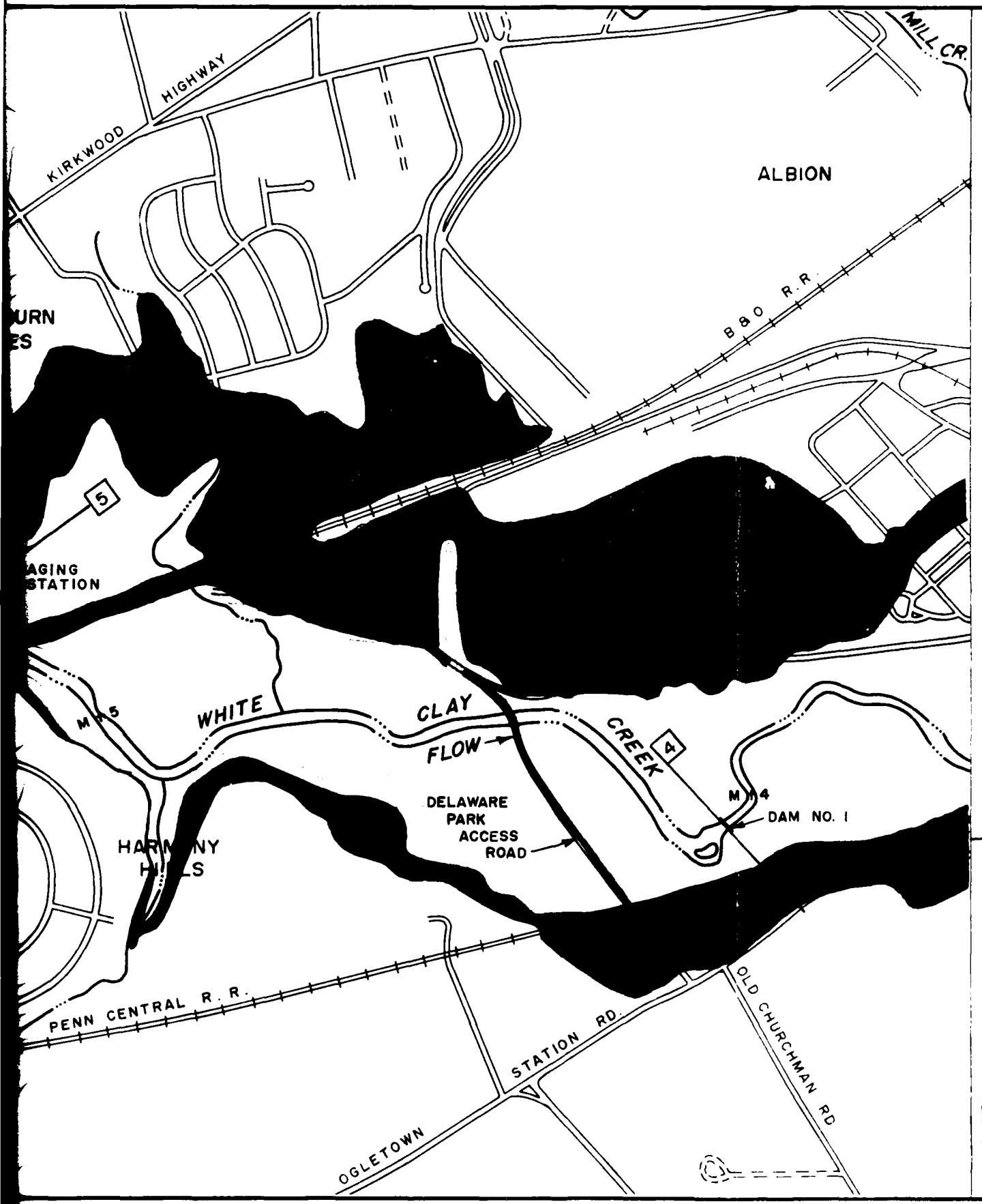
FLOOD PLAIN INFORMATION
WHITE CLAY CREEK
NEW CASTLE COUNTY, DEL.

FLOODED AREAS

JULY 1972

PLATE 5


MATCH LINE PLATE 5
KIRKWOOD
ROBERT
2
EASTBURN ACRES
STUDY LIMIT
CHOATE
PEIKEN PARK
5
BROOKHAVEN
GAGING STATION
SPRINGLAKE
RD.
NEWARK ESTATES
TAMARA
RD.
HARMONY
PENN CENTRAL
RD



M + 6

5

NOTES

1. MAP BASE
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4. MINIMUM

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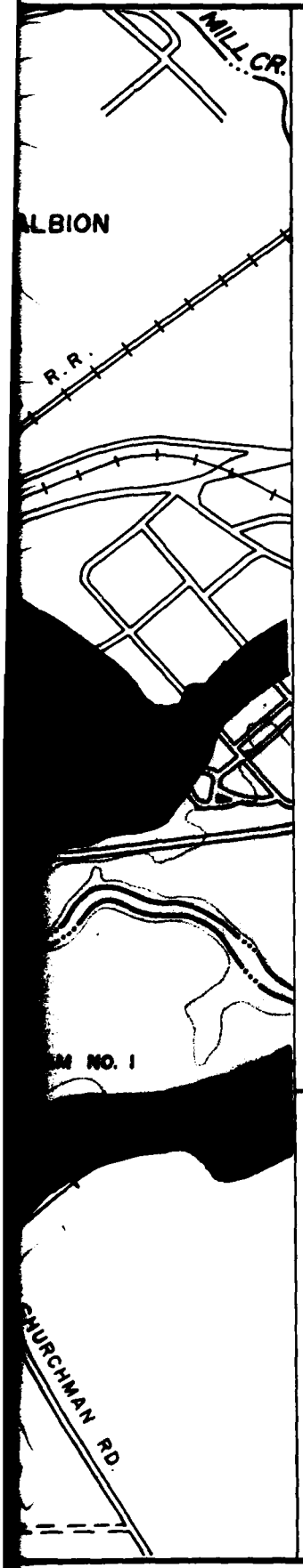

MATCH LINE PLATE 7

MATCH LINE PLATE 8

LEGEND

OVERFLOW LIMITS

INTERMEDIATE REGIONAL FLOOD — STANDARD PROJECT FLOOD

M+6 MILES ABOVE MOUTH

5 CROSS SECTION

GROUND ELEVATION IN FEET (U.S.C.& G.S. 1929 ADJ.) SEA LEVEL DATUM

CHANNEL

CITY OR BORO LIMITS

NOTES

1. MAP BASED ON U.S.G.S. 7.5 MIN. QUADRANGLE SHEETS NEWARK WEST, MD.-DEL.-PA., 1953, NEWARK EAST, DEL., 1953 & WILMINGTON SOUTH, DEL.-N.J. 1967. MINOR ADDITIONS AND ADJUSTMENTS MADE BY CORPS OF ENGINEERS.
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4. MINIMUM CONTOUR INTERVAL IS 10 FT.

SCALE IN FEET

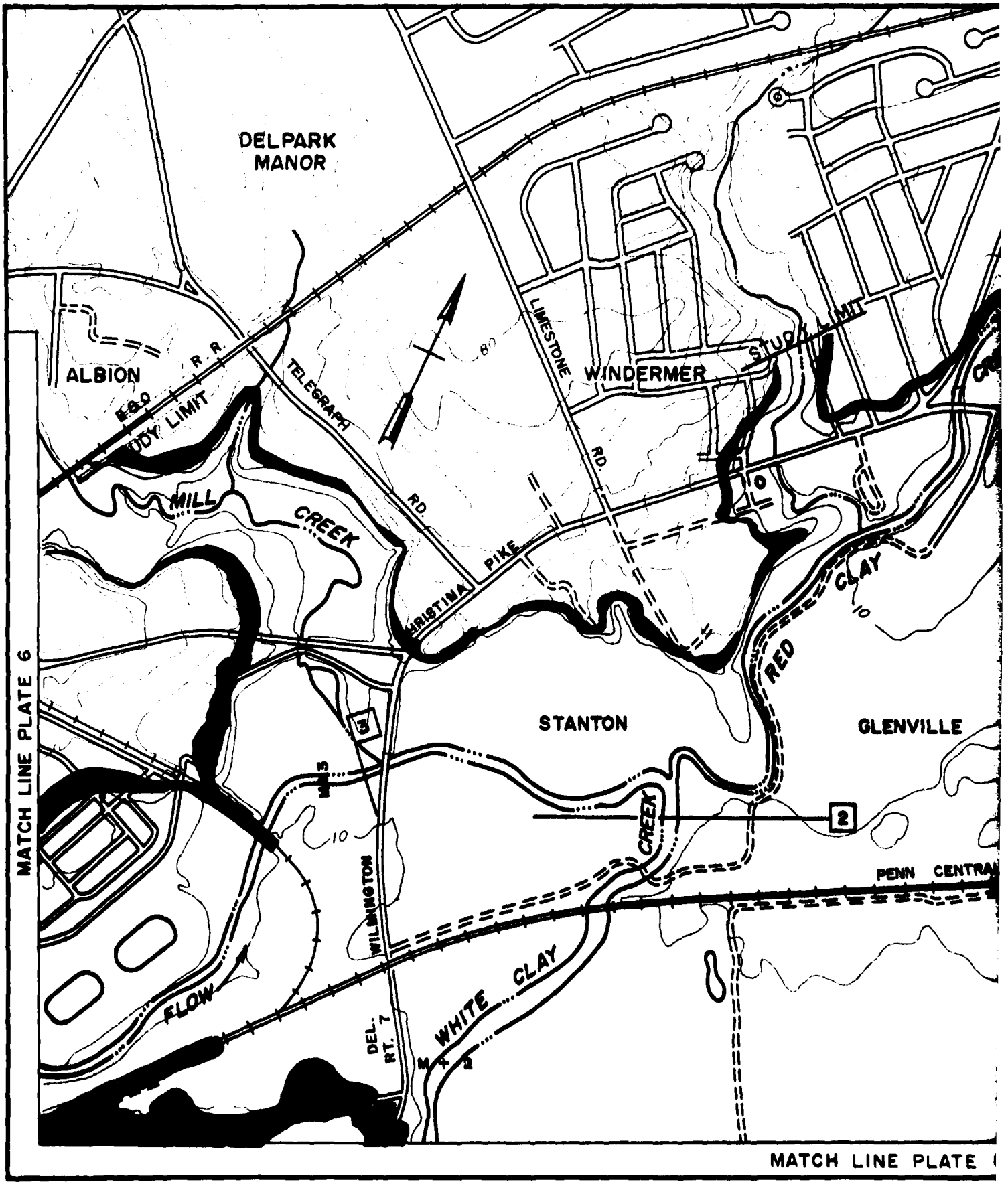
0 800 1600

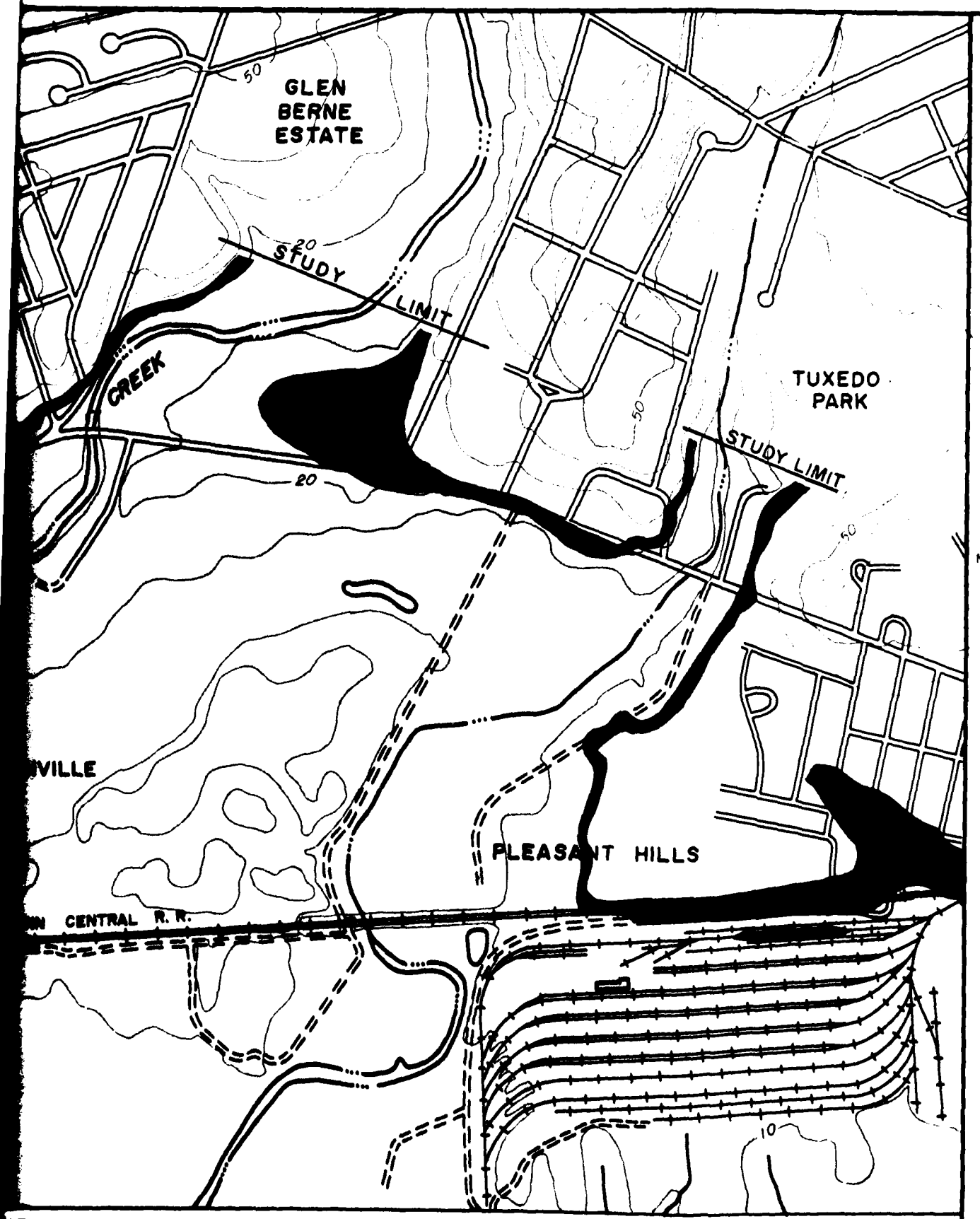
DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

FLOOD PLAIN INFORMATION
WHITE CLAY CREEK
NEW CASTLE COUNTY, DEL.

FLOODED AREAS
JULY 1972

PLATE 6


DELPARK MANOR
ALBION
R. R.
E&O
STUDY LIMIT
TELEGRAPH RD.
LIMESTONE RD.
WINDERMER
STUDY LIMIT
MILL CREEK
PIKE
CLAY
RED
STANTON
GLENVILLE
WILMINGTON
CREEK
PENN CENTRAL
FLOW
DEL. RT. 7
WHITE CLAY
MATCH LINE PLATE 6
MATCH LINE PLATE



OVERF

INTER
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FLOOD

M+3 MILES

2 CROSS

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G.S.

CHANN

NOTES

1. MAP BASED ON U.S.
SHEETS NEWARK WE
NEWARK EAST, DEL.
DEL.-N.J. 1967. M
ADJUSTMENTS MADE

2. LIMITS OF OVERFL
ACTUAL LOCATION
THE REPORT.

3. AREAS OUTSIDE THI
SUBJECT TO FLOOD

4. MINIMUM CONTOUR

0

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FLOOD PL
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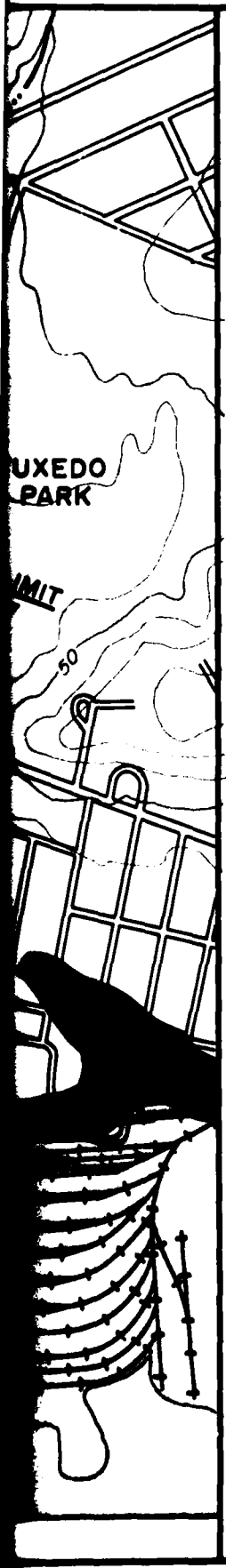
E PLATE 8



LEGEND

OVERFLOW LIMITS

INTERMEDIATE REGIONAL FLOOD — STANDARD PROJECT FLOOD

M + 3 MILES ABOVE MOUTH

2 CROSS SECTION

300 GROUND ELEVATION IN FEET (U.S.C.& G.S. 1929 ADJ.) SEA LEVEL DATUM

CHANNEL

NOTES

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4. MINIMUM CONTOUR INTERVAL IS 10 FT.

SCALE IN FEET

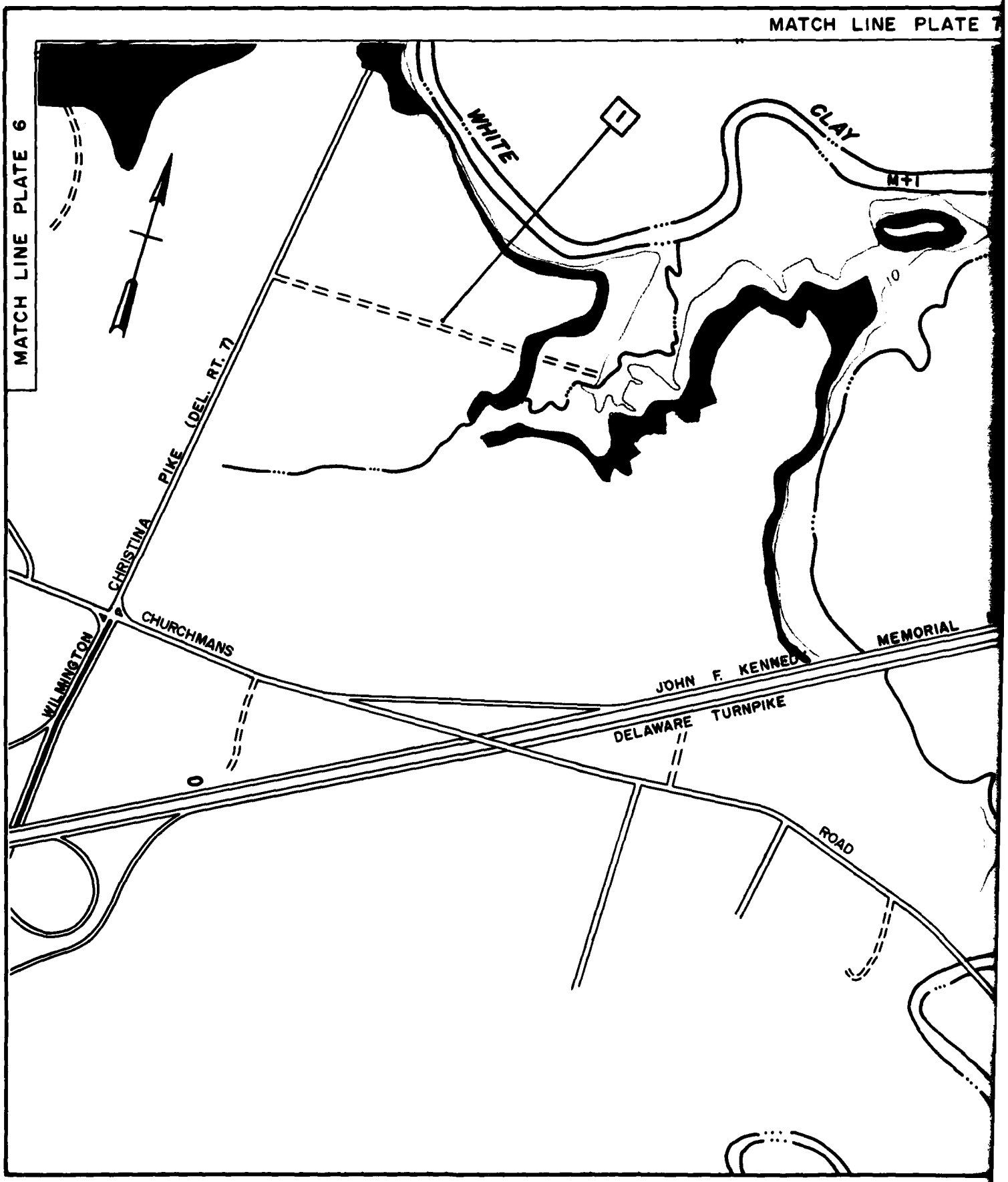
0 800 1600

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

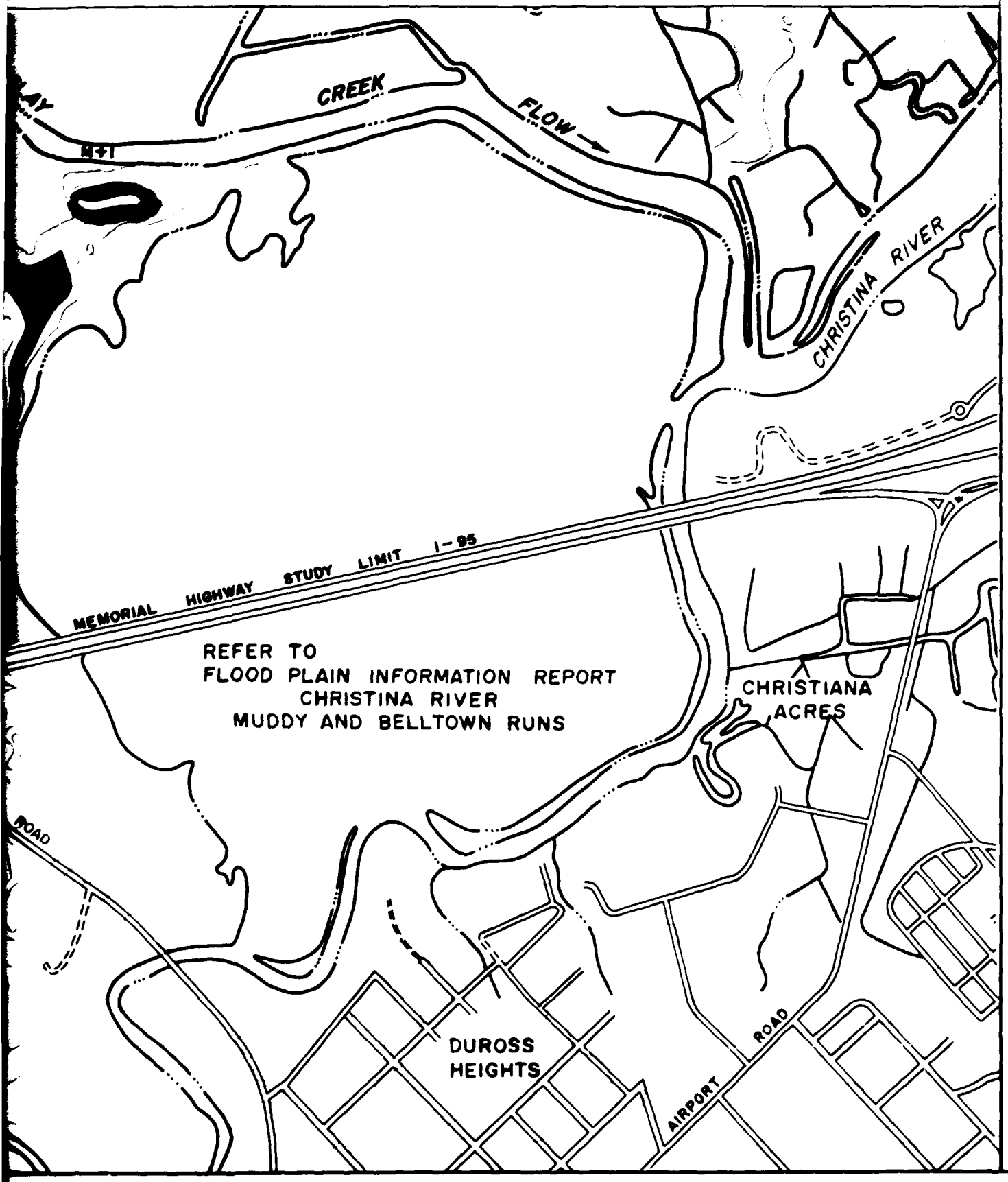
FLOOD PLAIN INFORMATION
WHITE CLAY CREEK
NEW CASTLE COUNTY, DEL.

FLOODED AREAS
JULY 1972

PLATE 7


MATCH LINE PLATE 7
MATCH LINE PLATE 6
WHITE
CLAY
M+I
10
CHRISTINA PIKE (DEL. RT. 7)
WILMINGTON
CHURCHMANS
JOHN F. KENNEDY MEMORIAL
DELAWARE TURNPIKE
ROAD

CH LINE PLATE 7



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1. MAP BA
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2. LIMITS
ACTUAL
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3. AREAS
SUBJEC

4. MINIMU

PHILAD

LEGEND

OVERFLOW LIMITS

INTERMEDIATE REGIONAL FLOOD — STANDARD PROJECT FLOOD

M + I — MILES ABOVE MOUTH

1 — CROSS SECTION

GROUND ELEVATION IN FEET (U.S.C.& G.S. 1929 ADJ.) SEA LEVEL DATUM

CHANNEL

NOTES

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SCALE IN FEET

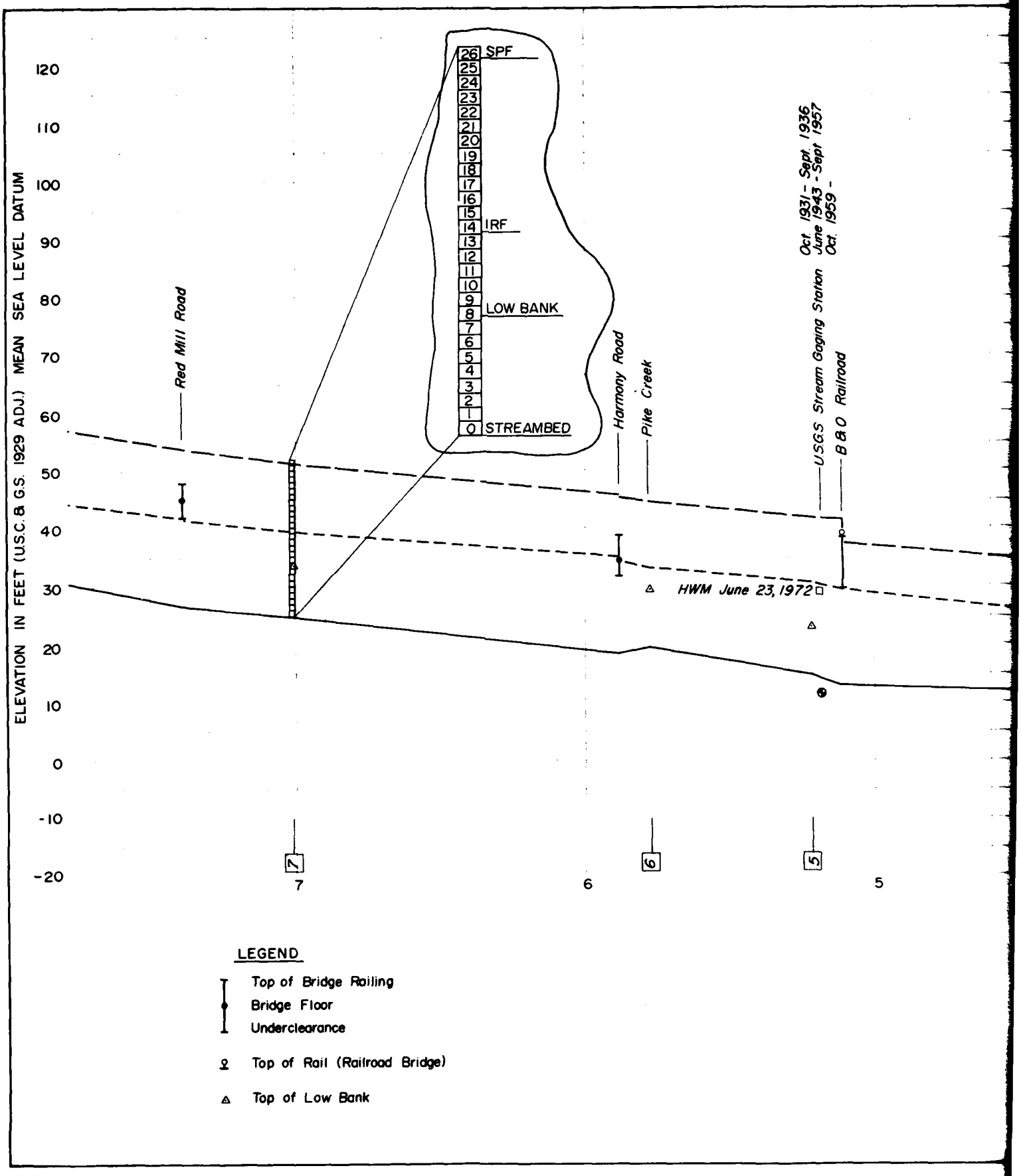
0 800 1600

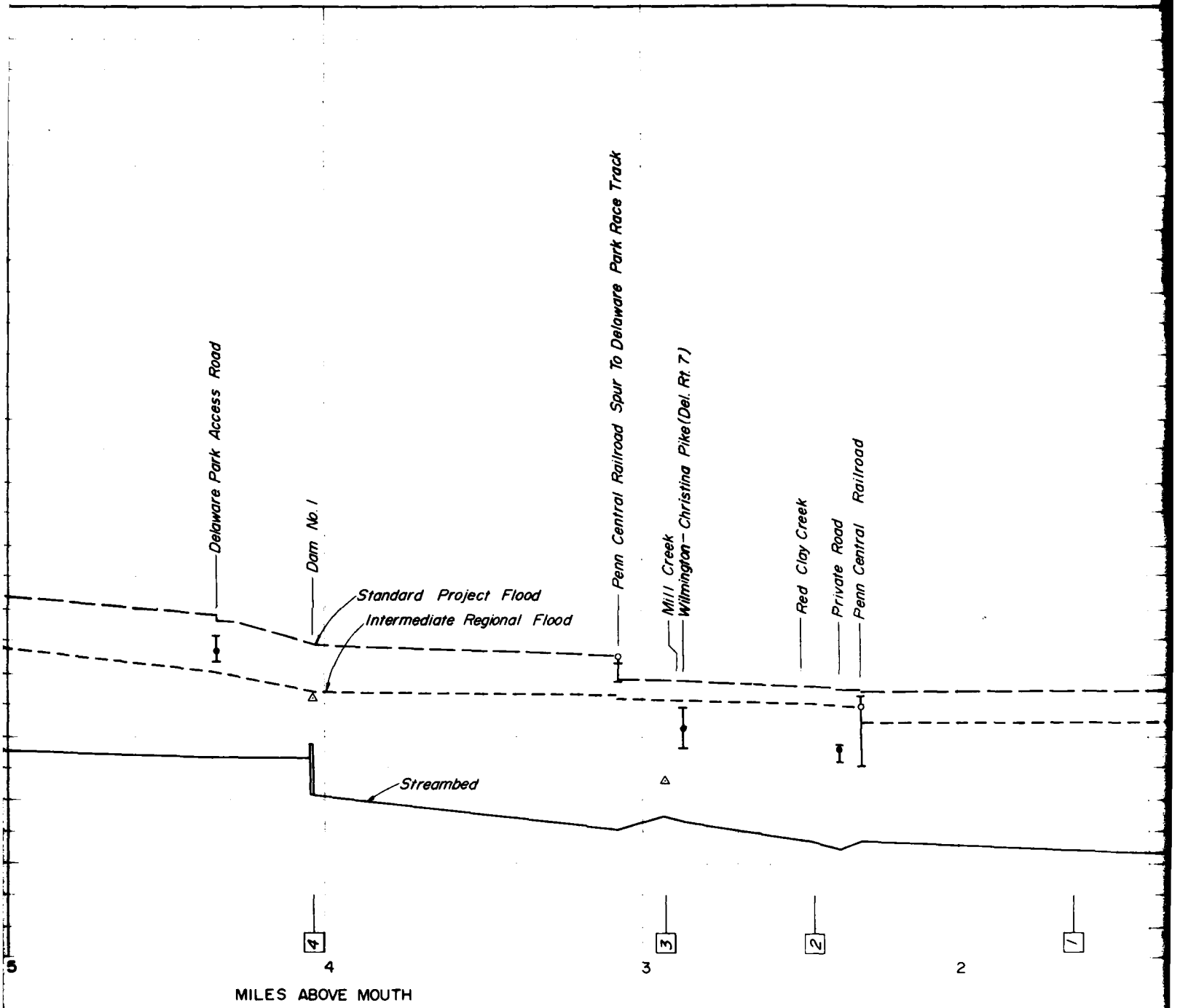
DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

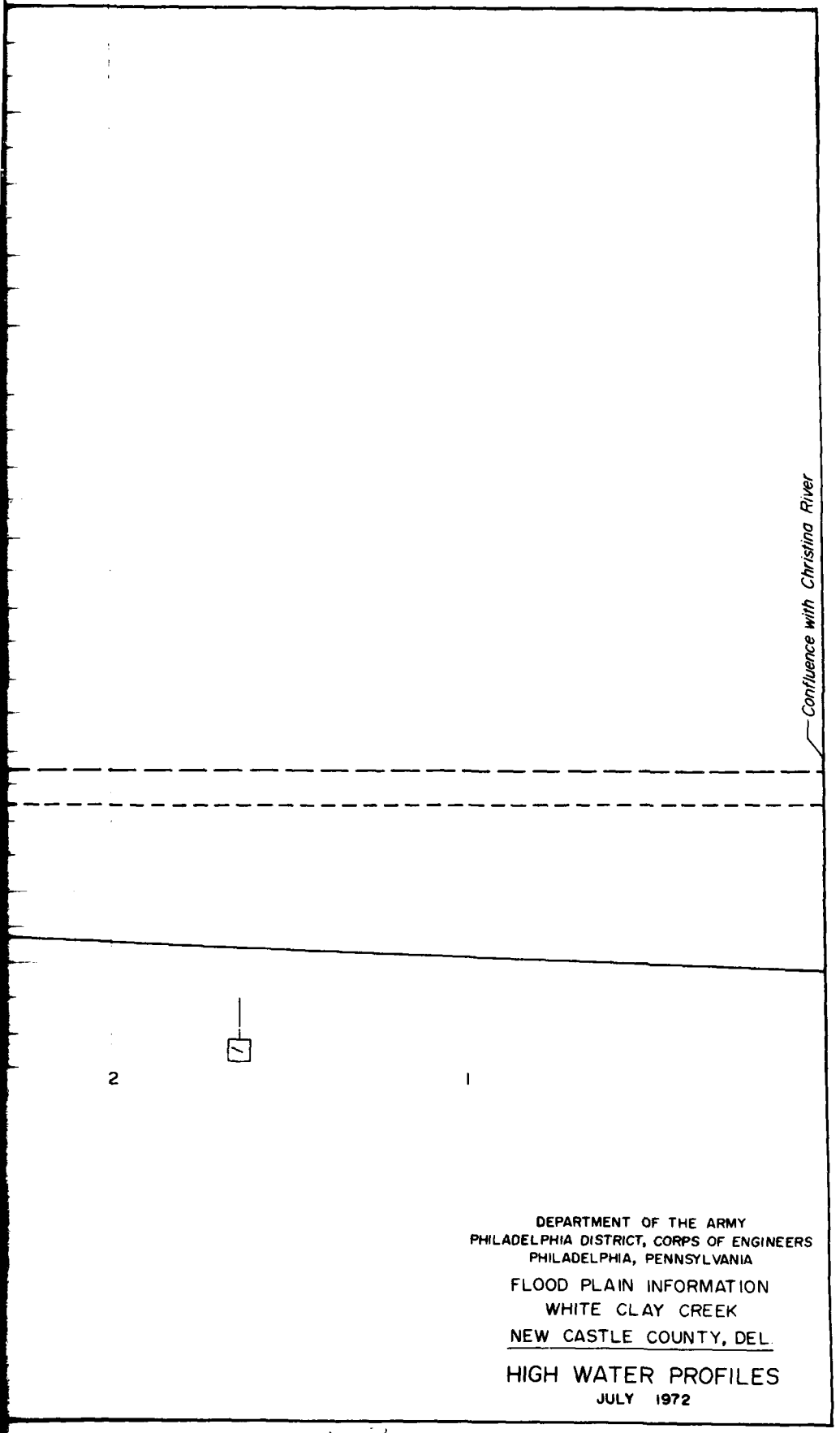
FLOOD PLAIN INFORMATION
WHITE CLAY CREEK
NEW CASTLE COUNTY, DEL.

FLOODED AREAS
JULY 1972

PLATE 8


ELEVATION IN FEET (U.S.C.& G.S. 1929 ADJ.) MEAN SEA LEVEL DATUM
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
26 SPF
14 IRF
9 LOW BANK
0 STREAMBED
Red Mill Road
Harmony Road
Pike Creek
USGS Stream Gaging Station
Oct. 1931 - Sept. 1936
June 1943 - Sept 1957
Oct. 1959 -
B & O Railroad
HWM June 23, 1972
7
6
5
LEGEND
Top of Bridge Railing
Bridge Floor
Underclearance
Top of Rail (Railroad Bridge)
Top of Low Bank


Delaware Park Access Road
Dam No. 1
Standard Project Flood
Intermediate Regional Flood
Penn Central Railroad Spur To Delaware Park Race Track
Mill Creek
Wilmington-Christina Pike (Del. Rt. 7)
Red Clay Creek
Private Road
Penn Central Railroad
Streambed
4
3
2
1
5
4
3
2
MILES ABOVE MOUTH

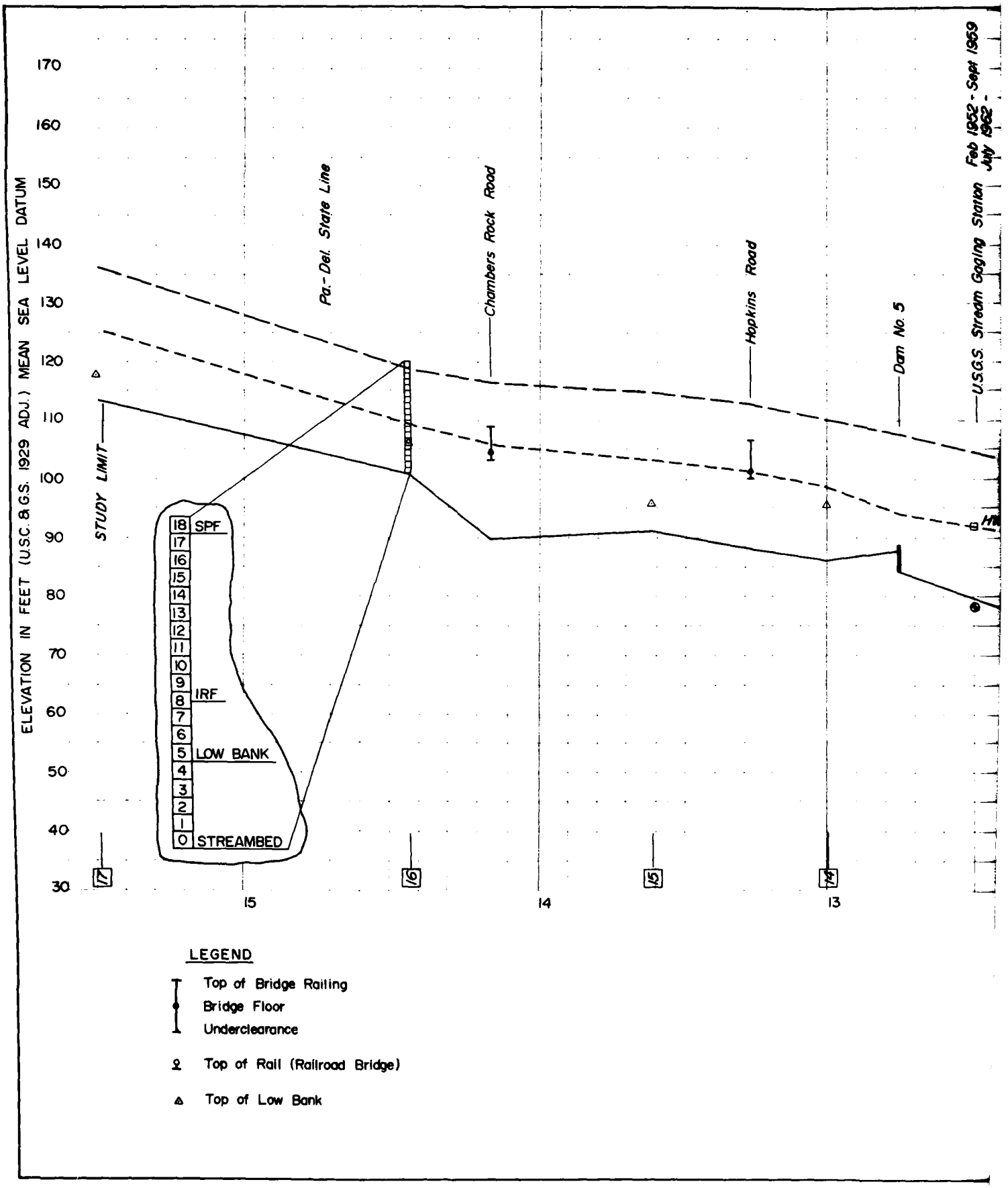


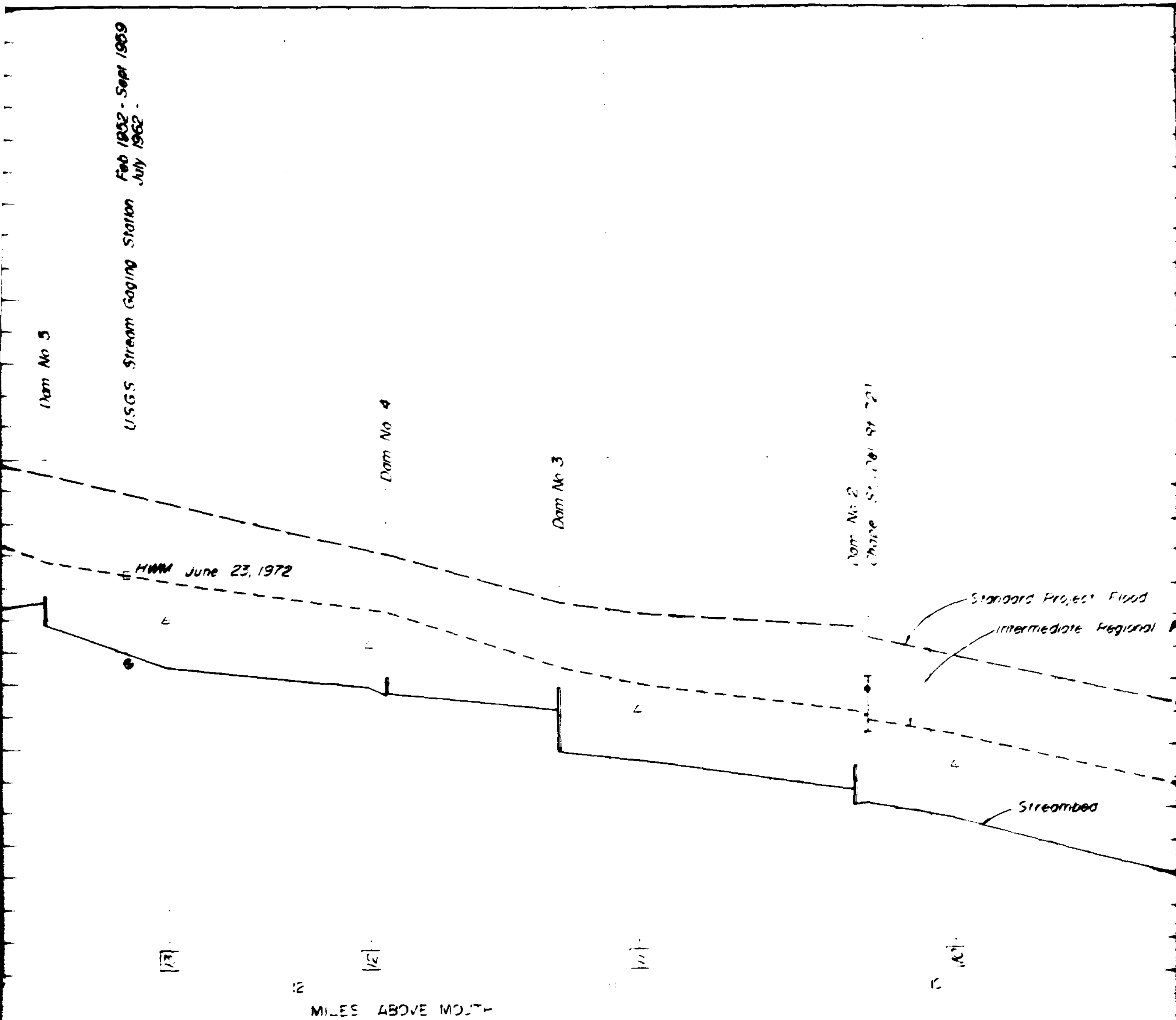
DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

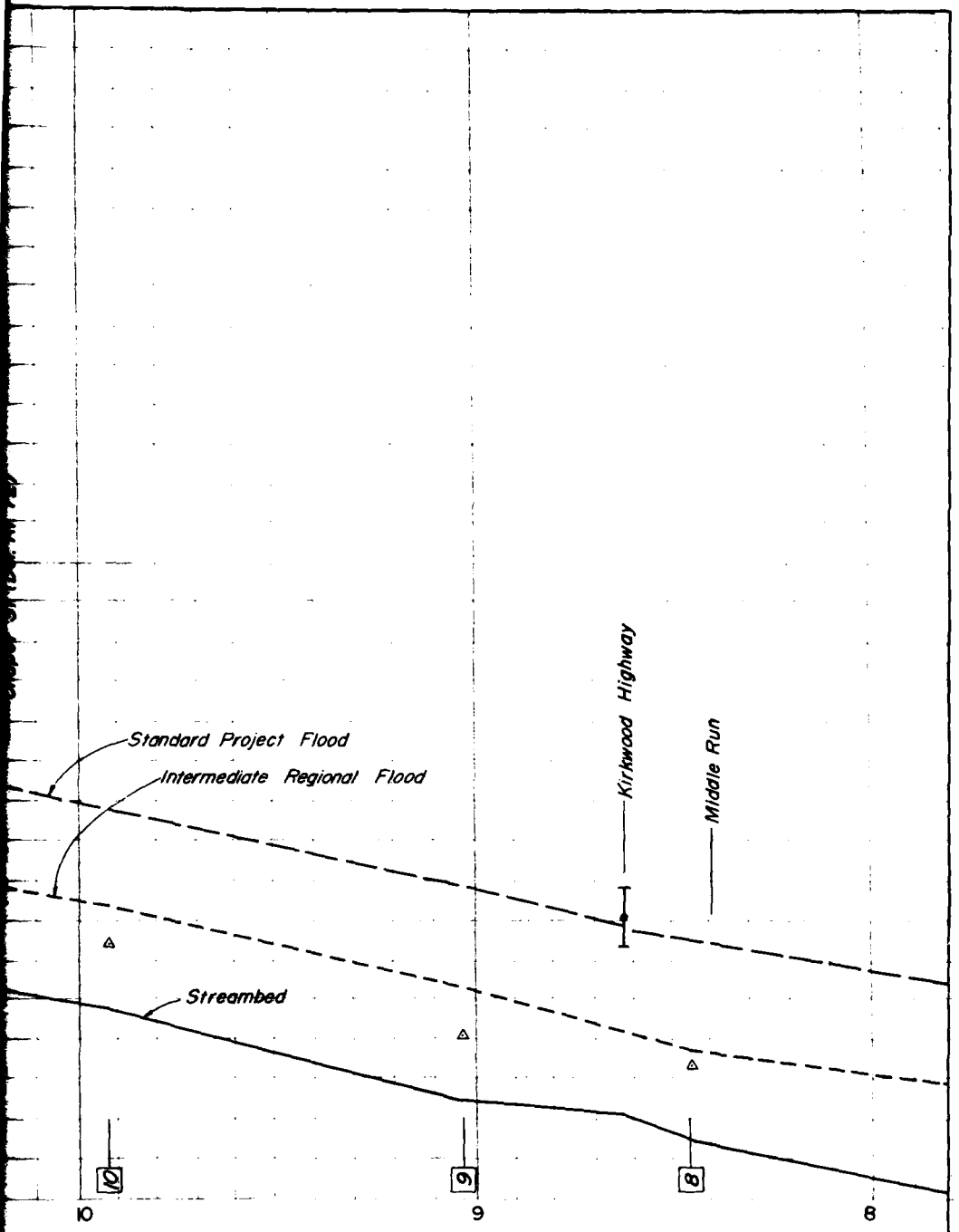
FLOOD PLAIN INFORMATION
WHITE CLAY CREEK
NEW CASTLE COUNTY, DEL.

HIGH WATER PROFILES
JULY 1972

PLATE 9


ELEVATION IN FEET (U.S.C. & G.S. 1929 ADJ.) MEAN SEA LEVEL DATUM
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
STUDY LIMIT
Pa.-Del. State Line
Chambers Rock Road
Hopkins Road
Dam No. 5
U.S.G.S. Stream Gaging Station Feb 1952 - Sept 1959 July 1962 -
18 SPF
17
16
15
14
13
12
11
10
9 IRF
8
7
6
5 LOW BANK
4
3
2
1
0 STREAMBED
17
16
15
14
15
14
13
LEGEND
Top of Bridge Railing
Bridge Floor
Underclearance
Top of Rail (Railroad Bridge)
Top of Low Bank


Dam No 5
USGS Stream Gaging Station Feb 1952 - Sept 1969
July 1962 -
Dam No 4
Dam No 3
Dam No 2
HWM June 23, 1972
Standard Project Flood
Intermediate Regional
Streambed
12
MILES ABOVE MOUTH

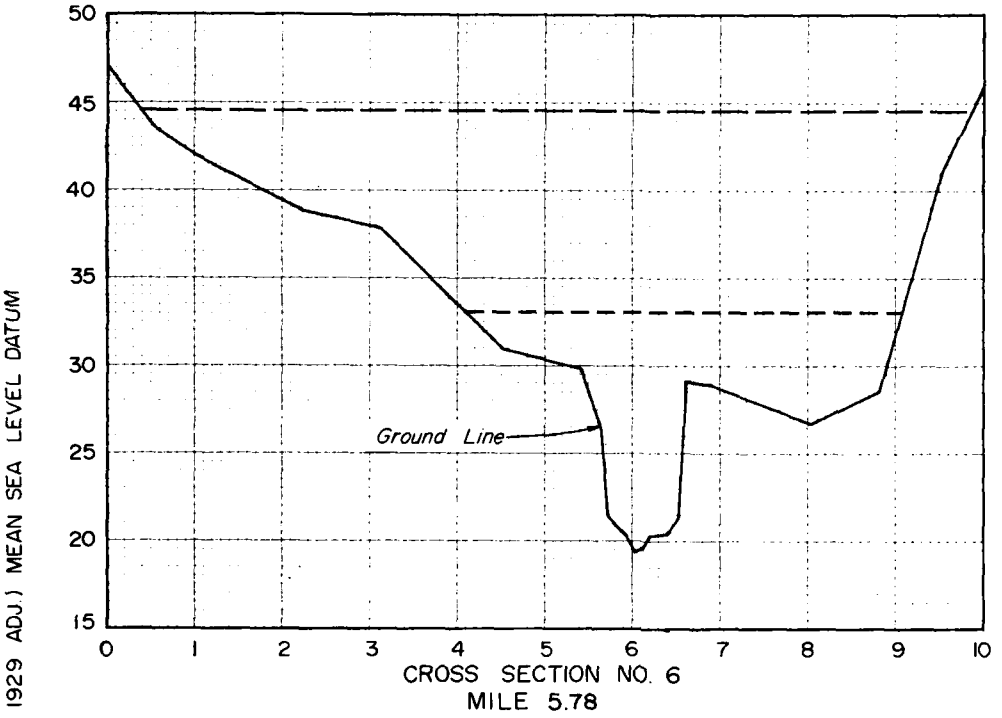


DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

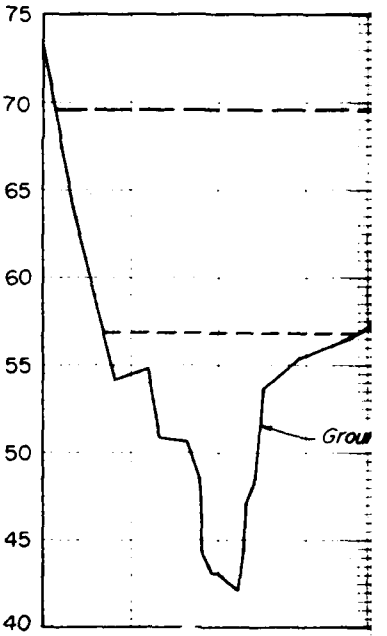
FLOOD PLAIN INFORMATION
WHITE CLAY CREEK
NEW CASTLE COUNTY, DEL.

HIGH WATER PROFILES
JULY 1972

PLATE 10

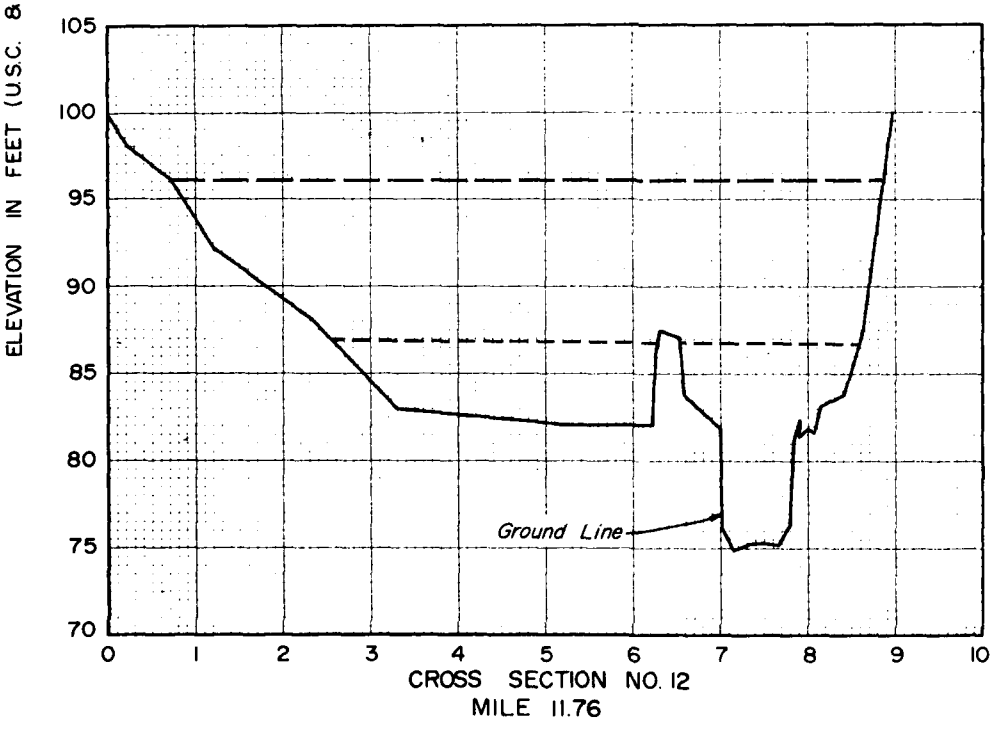


CROSS SECTION NO. 6
MILE 5.78

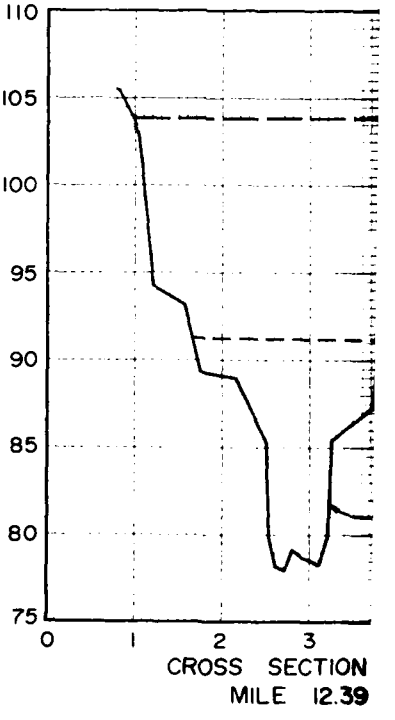


CROSS SECTI
MILE 9.(

ELEVATION IN FEET (U.S.C. & G.S. 1929 ADJ.) MEAN SEA LEVEL DATUM

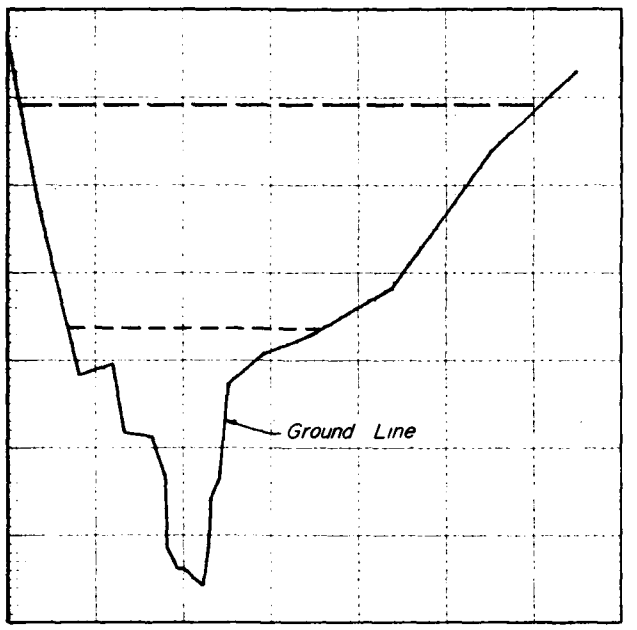


CROSS SECTION NO. 12
MILE 11.76

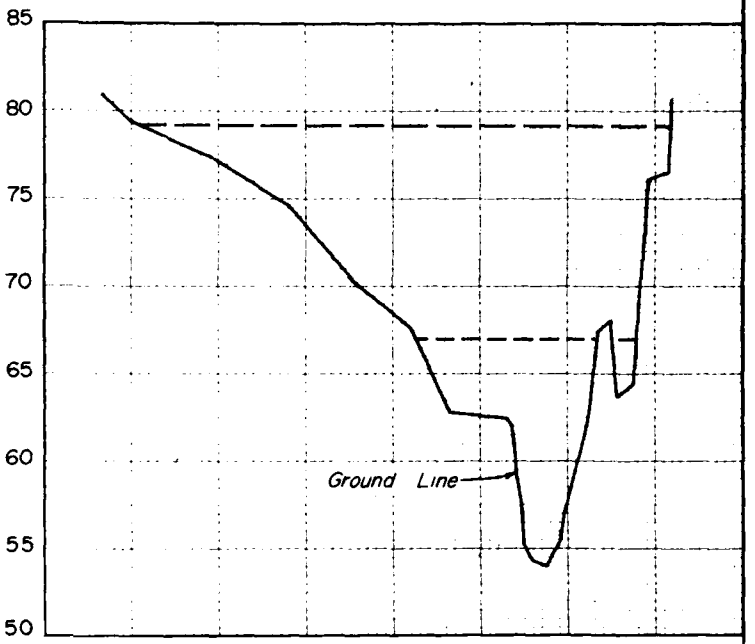


CROSS SECTION
MILE 12.39

HORIZONTAL DISTANCE IN HUNDREDS OF FEET



CROSS SECTION NO. 9
MILE 9.03



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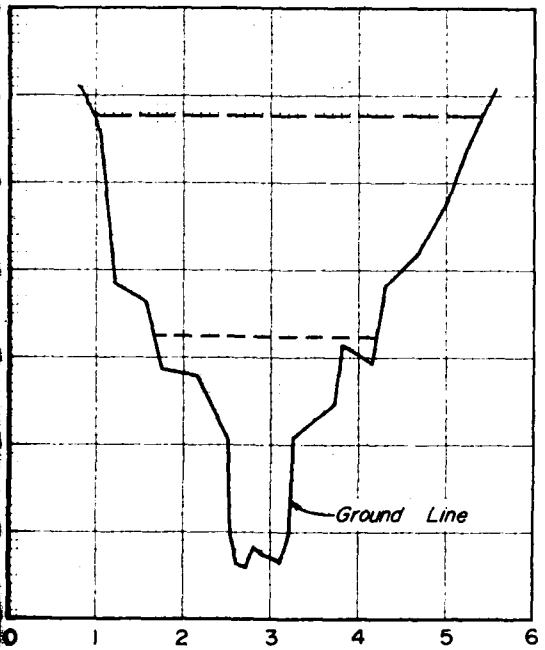
MILE 9.92



CROSS SECTION NO. 13
MILE 12.39

LEGEND

—— Standard Project Flood

– – – Intermediate Regional Flood

NOTE:

The 8 sections not shown in this report are on file at the Philadelphia District Corps of Engineers and are available for inspection upon request.

Cross sections taken looking downstream.

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

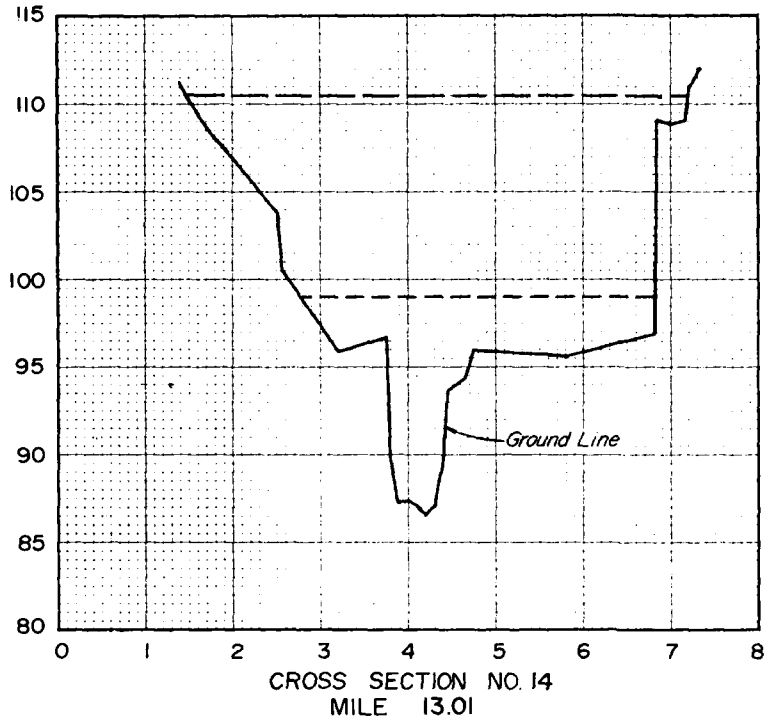
FLOOD PLAIN INFORMATION
WHITE CLAY CREEK
NEW CASTLE COUNTY, DEL.

SELECTED CROSS SECTIONS

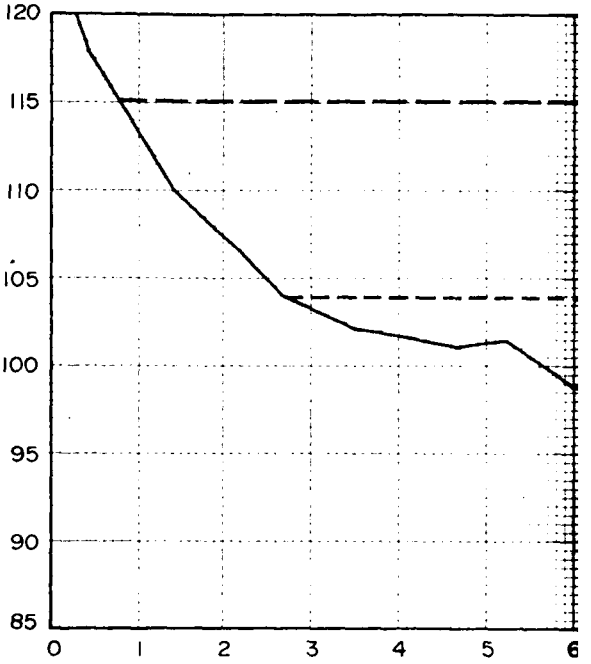
JULY 1972

FEET

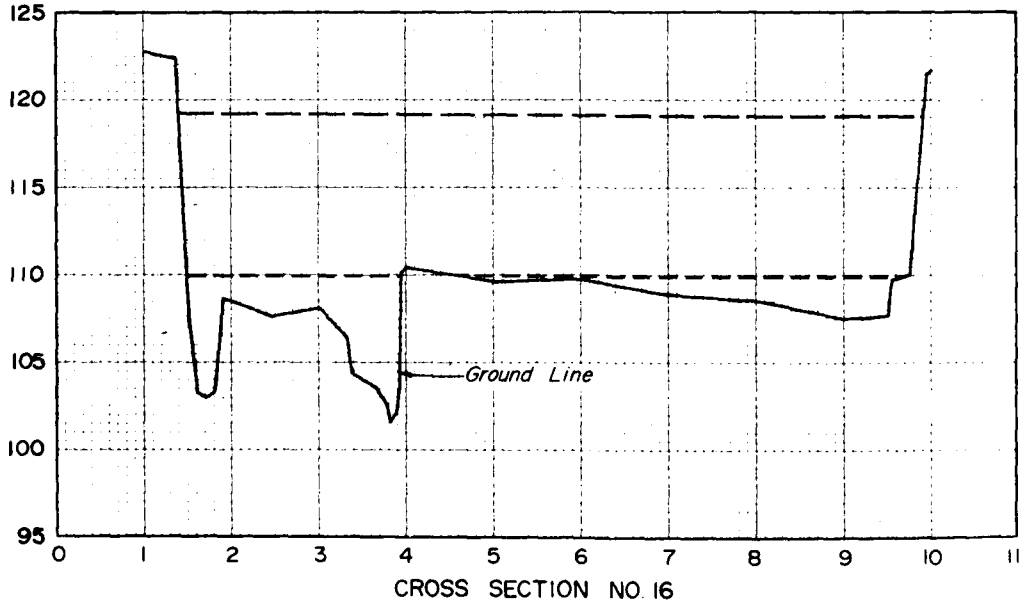
PLATE 11



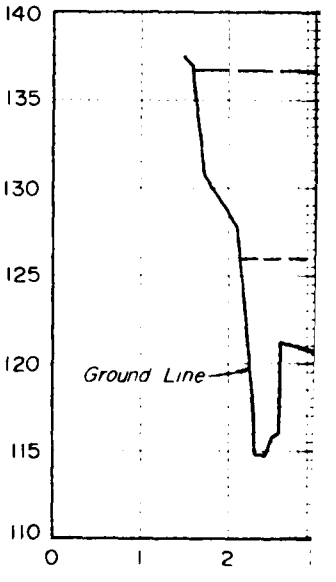
CROSS SECTION NO. 14
MILE 13.01



ELEVATION IN FEET (U.S.C & GS. 1929 ADJ.) MEAN SEA LEVEL DATUM

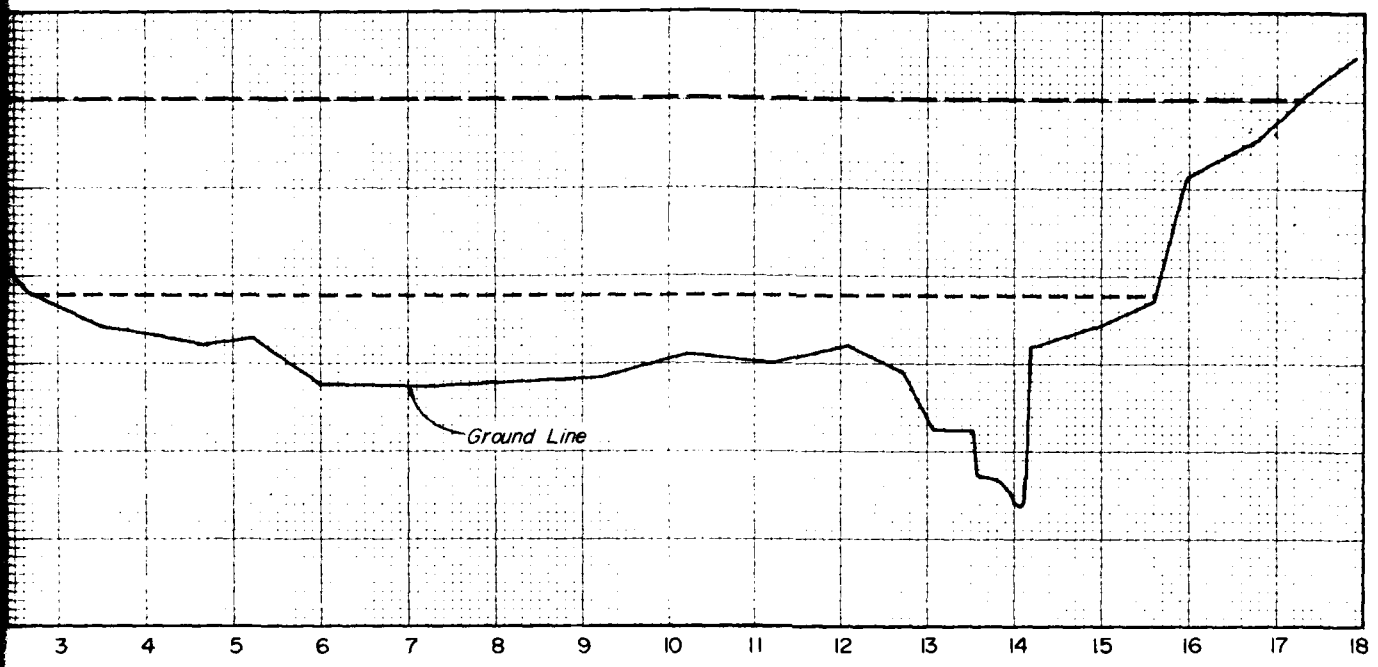


CROSS SECTION NO. 16
MILE 14.45



CROSS
MI

HORIZONTAL DISTANCE IN HUNDREDS OF FEET



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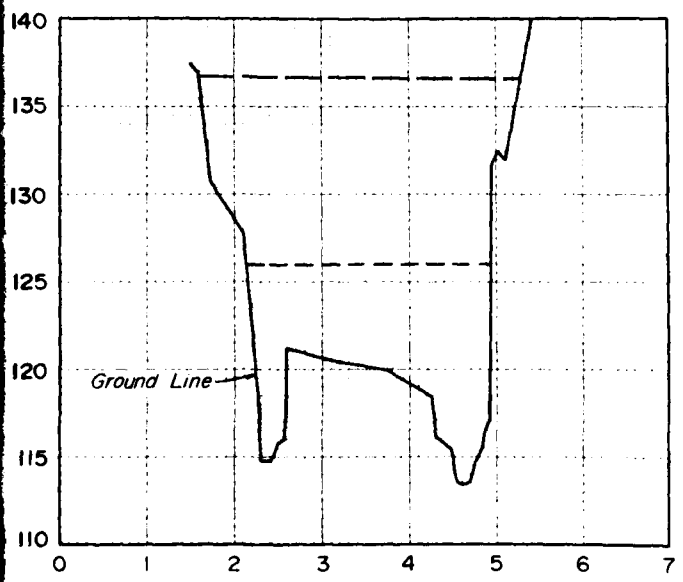
MILE 13.62



CROSS SECTION NO 17
MILE 15.51

LEGEND

—— Standard Project Flood

– – – Intermediate Regional Flood

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Cross sections taken looking downstream.

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

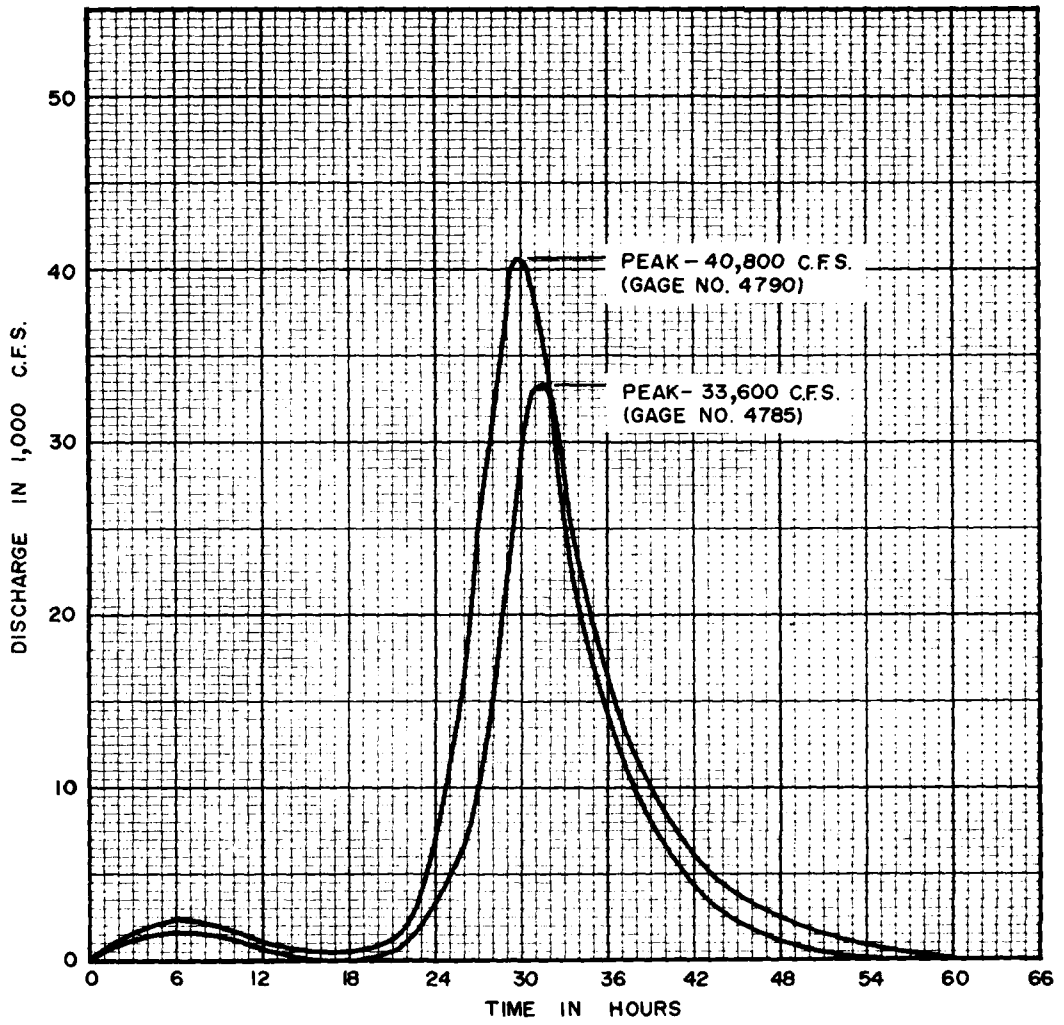
FLOOD PLAIN INFORMATION
WHITE CLAY CREEK
NEW CASTLE COUNTY, DEL

SELECTED CROSS SECTIONS

JULY 1972

DS OF FEET

PLATE 12



GAGE NO. 4785: NORTH OF NEWARK, DELAWARE AT TWEEDS MILL ROAD BRIDGE (D.A. 66.7 SQ. MI.)

GAGE NO. 4790: EAST OF NEWARK, DELAWARE 350 FT. EAST OF B&O RAILROAD BRIDGE (D.A. 87.8 SQ. MI.)

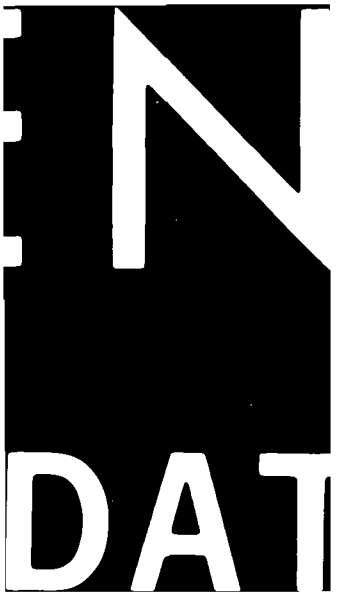
DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

FLOOD PLAIN INFORMATION
WHITE CLAY CREEK
NEW CASTLE COUNTY
DELAWARE

STANDARD PROJECT FLOOD
HYDROGRAPH

JULY 1972

PLATE 13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